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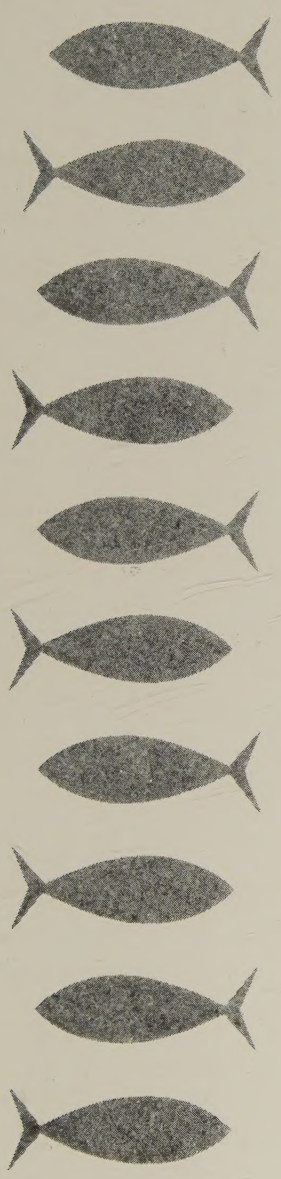

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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

AMLR Research Cruise Completed

Following completion of Leg I of the Antarctic Marine Living Resources (AMLR) research cruise in the waters surrounding Elephant Island, Antarctica, the NOAA Ship *Surveyor* returned to Punta Arenas, Chile on January 31, 1990 for a mid-cruise port call. The port call allowed for exchange of scientific personnel and loading of supplies and fuel. Rennie Holt and Izadore Barrett joined the ship as cruise leaders for Leg II. On February 4, 1990, the *Surveyor* departed Punta Arenas to transit back to the Elephant Island study area. In the early part of the transit, the *Surveyor* exited the Beagle Channel and headed on a southwesterly course around Cape Horn to Isla Diego Ramirez while collecting bathymetric data. The Seabeam swath survey system was used to collect data on a trackline requested by the Pacific Marine Environmental Laboratory across the Drake Passage. Upon reaching King George Island in the South Shetland Islands, the *Surveyor* turned northeast and transited to Elephant Island to begin the third research survey. In addition to Seabeam data collection, marine mammal and bird observations were made during the entire transit to the study area.

A total of four 7-day surveys (two on each leg) was planned for the AMLR cruise. The third survey was begun on February 7 and ended February 13. As with all the surveys, it consisted of a hydroacoustic study for krill, interrupted by Conductivity-Temperature-Depth (CTD) casts for physical oceanography studies, bongo net tows for direct krill studies, and rosette casts for phytoplankton/primary production studies. The third survey followed a north-south trackline (a replicate of the first survey on Leg I). Unfortunately, as in Leg I the V-fin depressor used in the hydroacoustic study suffered significant damage; however, the ingenuity of the crew prevailed in the repair of it.

A permanent field camp on Seal Island, a small island northwest of Elephant Island, is maintained in conjunction with bird and mammal foraging and reproductive studies. In mid-February, the five Seal Island scientists attempted to repair the National Weather Service (NWS) remote weather station that was damaged in the previous winter. The scientists observed eight subadult male fur seals entangled in marine debris on the island. Polyethylene line was the material most commonly observed on the seals. The breeding success studies on macaroni and chinstrap penguins were completed with the final chick counts. Fur seals and penguins tagged or banded as pups or chicks in previous seasons continued to be observed throughout February. Approximately 375 2-year old and 25 1-year old chinstrap penguins were resighted, and subadult macaroni penguins returned to the island to molt.

John Bengtson and Peter Boveng were picked up from Seal Island on February 14, 1990 by the *Surveyor* to take part in crabeater seal studies in the pack ice of the Weddell Sea. The *Surveyor* sailed farther South than ever before in its 30 year career, reaching 65°24.2'S, 55°51.3'W on February 15 before being turned back by ice. The objectives of the crabeater seal studies were to deploy satellite-linked transmitters on selected seals and to collect specimen material. The studies were very successful, and data transmissions of the geographic locations of tagged seals were almost immediately received via satellite. The crabeater seal studies were completed on February 19, and Bengtson and Boveng were returned to Seal Island the following day.

Reproductive success and feeding studies were completed towards the end of February on Seal Island. The field team prepared the camp for the upcoming winter and for departure on the *Surveyor* on February 27, 1990.

The fourth hydroacoustic survey, following an east-west trackline (a replicate of the second survey on Leg I), was begun on February 21 and completed on February 27. Along with CTD casts and bongo net tows, the MOCNESS net was deployed once. As in the first three surveys, Seabeam bathymetric data were collected continuously. The Seal Island field party was picked up on February 27, along with their gear and refuse. On March 1, after large concentrations of krill were located, two MOCNESS net tows were conducted.

On March 1, 1990, the U.S. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Inspector Laura Claywell (of the *Surveyor*), Rennie Holt, and John Wormuth (Texas A & M University) boarded the Japanese fishing vessel, *Aso Maru*, to determine compliance with rules and regulations specified by the CCAMLR System of Observation and Inspection. (CCAMLR is part of the Antarctic Treaty System.) This inspection was a first for the AMLR program, and it went well in

all respects. The captain of the Japanese vessel was most cooperative and helpful, and no violations were found.

Leg II of the cruise was completed on March 5, 1990, when the *Surveyor* returned to Punta Arenas, Chile. After a short port call, the *Surveyor* began its northbound transit back to Seattle. Along the way, a census of seabirds over the continental shelf of Peru was completed. The *Surveyor* returned to Seattle on April 16, 1990. (J. Rosenberg, FTS 893-7600)

AERG Scientist Takes Part in South African Antarctic Research

Roger Hewitt was invited by the government of South Africa to participate in a research cruise conducted to study the formation and persistence of krill swarms in the southern oceans. The cruise was part of South Africa's contribution to the work of the CCAMLR scientific committee. More specifically, the objectives of the cruise were: 1) map spatial and temporal characteristics of concentrations of krill swarms subject to commercial fishing; 2) investigate selected krill swarms in relation to environmental gradients; and 3) conduct a meridional series of hydrographic stations across sub-tropical and sub-Antarctic fronts.

The cruise took place on the R/V *Africana*, which left Cape Town, South Africa on February 12, 1990. The *Africana* is 235 feet in length and is well-equipped with four deck winches, four multi-purpose trawling winches, a heavy-pull net reel, three cranes, and numerous booms and gantries. There is also a variety of well-fitted research laboratories on the ship. The ship was designed to conduct acoustic surveys; she maintains state-of-the- art equipment to implement such surveys.

Hewitt found the *Africana's* accommodations spacious and very comfortable and the ship's complement well staffed. In addition to several biologists and oceanographers, the scientific party also included two electronic technicians to maintain the various sensors, a fishing master to assist the captain and mend net, and two gear technicians to operate the small winches and maintain the scientific sampling gear.

During the *Africana's* 17 day transit from Cape Town to the South Orkney Islands (east of the tip of the Antarctic Peninsula), mid-water trawls were deployed every night to sample meso-pelagic fish on an east-to-west transect across the South Atlantic Ocean at 34°S. Trawl operations were very efficient; the gear was made ready and deployed in a matter of minutes with control of the net reel, trawl warps and net sonde maintained on the bridge. In addition, primary production studies were done using a "magnum" rosette with a CTD and fluorometer. As part of South Africa's contribution to the World Ocean Circulation Experiment (WOCE), a north-to-south line of deep CTD/rosette casts was made at 13°W in order to delineate the subtropical and sub-antarctic convergences.

After arriving in the vicinity of the South Orkney Islands, the *Africana* conducted a broad scale acoustic survey for krill. In summary, the following general observations were made in the vicinity of Coronation Island (the largest of the South Orkney Islands): 1) there was an extensive concentration of krill swarms (approximately 600 km^2) at the western end of the island; 2) a Soviet fleet was actively fishing in the area; 3) there were two persistent high-density krill areas associated with submarine canyons and westerly counter-currents; 4) the krill were large, reproductively mature, and actively feeding; and 5) there was evidence for vertical diel migration.

On March 8, 1990, Hewitt and members of the South African scientific party visited the British Antarctic Survey base at Signy Island on the south side of Coronation Island. The British base team (22 strong including scientific and support personnel) was very hospitable, and the *Africana* party was treated to a tour of the island. A recent census counted 16,000 bachelor fur seals on Signy Island; only limited breeding was apparent with six pups counted. Interestingly, Signy Island was not occupied by fur seals before they were heavily harvested in the 19th century.

The *Africana* then headed west to the South Shetland Islands and conducted a broad scale acoustic survey for krill along the northern side of Elephant and Clarence Islands. In summary, the following observations were made: 1) there was a concentration of krill swarms (approximately 100 km^2) along the shelf break on the north side of Elephant Island; 2) there were four Japanese vessels actively fishing in the area; 3) there were krill swarms associated with 100-200 m depth contours east of Seal Island in an area of counter-currents and eddies; 4) the krill were mostly large sub- adults, reproductively immature, and not actively feeding; and 5) there was evidence for vertical diel migration.

The *Africana* left Elephant Island on March 18 and headed across the Drake Passage to Punta

Arena, Chile for a port call. Hewitt arrived back in San Diego on March 25, 1990. (J. Rosenberg, FTS 893-7600)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

COASTAL EASTERN PACIFIC POPULATION BIOLOGY OF FISHES

Physiology-Genetics Laboratory Started

Russell D. Vetter has recently joined the Coastal Division as a research physiologist. Previously Vetter was a member of the research faculty at Scripps Institution of Oceanography. He received his undergraduate degree from Southampton College in New York, M.S. from the University of Texas, and his Ph.D. in biochemistry from the University of Georgia. His expertise is in the use of various biochemical and physiological indicators to determine the effects of natural and anthropogenic environmental factors on the condition of marine organisms. This work is embodied in 37 papers (some 20 on fish). Most recently he has focused on the biochemistry and physiology of hydrothermal vent animals and has participated in several expeditions to hydrothermal vent communities. He has extensive experience with shipboard physiological experiments and in the use of research submersibles such as the *Alvin*.

He will be starting a program on the physiological ecology and genetics of Dover sole and other deep-water groundfishes. The adaptations of these fish to the environmental conditions prevailing on the continental slope are relatively unstudied. The objectives of the program will be to determine growth rates, reproductive cycles, genetic structure and physiological adaptations of groundfish to environmental factors characteristic of the continental slope. Some of the factors that will be investigated include hypoxic conditions, low food availability, low temperature, increased pressure, and buoyancy regulation of eggs and larvae. He will also begin to investigate the genetic structure of different populations of slope fishes using techniques of mitochondrial DNA sequencing. (J. Hunter, FTS 893-7127)

Analysis on Data for Dover Sole Experiments

Chin Lai has completed the data analyses on the Dover sole experiments that were conducted on a recent CalCOFI cruise, as well as most of the on-going laboratory studies. The oxygen consumption rate of Dover sole acclimated to 4°C in the laboratory (260 to 870 g, n=4) ranged from 13 to 27 mg O_2/kg/h. Compared to wild Dover sole that were studied at sea, the larger fish caught at depths of 515 fathoms (mean weight=1000 g, n=3) have a $\dot{V}O_2$ range of 6 to 8 mg O_2/kg/h as opposed to 19 to 31 mg O_2/kg/h for the smaller field animals (mean weight=315 g, n=5) found in the shallower depths (158 fathoms). The current data suggest that both the laboratory acclimated and the smaller field animals have a similar oxygen consumption rate (i.e. this could be the maximum routine rate in these animals), but the larger field fish had an extremely low metabolic rate. The metabolic rate of the large field fish was only 1/4 to 1/2 that of any of the fish acclimated in the laboratory (regardless of size). This indicates that larger Dover sole in the sea acquired some special adaptations to the low O_2 zone. A larger sample size, however, is needed to test for significant differences among the different size groups. As such, another field study is planned and more laboratory acclimated fish will be studied. A similar on-going experiment done on the California halibut (280 to 2570 g, n=3) showed that the oxygen consumption rate was extremely high (57 to 84 mg O_2/kg/h) when compared to the Dover sole. (N. C. Lai, FTS 893-7105)

COASTAL EASTERN PACIFIC FISHERIES ENVIRONMENTAL INVESTIGATIONS

Remote Sensing Feasible for Defining Mackerel Habitat

Results from an investigation completed at the San Diego State University Department of Geography and the Southwest Fisheries Center, demonstrate that it is feasible to define the habitat of Pacific mackerel in the Southern California Bight using remote sensing techniques. The work was originally the topic of a M.S. degree thesis completed by Patsy Bearden, under the guidance of Dr. R. Michael Laurs, SWFC, and Professor Douglas Stow, SDSU. The initial investigation was broadened, the data were reanalyzed, and the thesis manuscript was revised and rewritten by Bearden, Laurs and Stow as a scientific article entitled "Definition of Pacific mackerel, *Scomber japonicus* Houttuyn, habitat during autumn in the Southern

California Bight using remote sensing techniques." The article will be submitted for publication in the scientific periodical Continental Shelf Research.

The commercial purse seine fishery for Pacific mackerel is centered in southern California. The catch has exhibited considerable fluctuation throughout the 60-year history that the fishery has operated. The fishery usually operates with the assistance of pilots in small aircraft who locate and estimate the size of schools of coastal pelagic fish species and radio the information to fishermen.

Pacific mackerel habitat relationships were examined in the Southern California Bight during autumn from 1981-85. Information on the distribution and availability of the Pacific mackerel were obtained from records of aerial sightings of schools complied into a computer database, Aerial Marine Resources Monitoring System (AMRS), by the Southwest Fisheries Center. The AMRS contains over 25 years of records of coastal pelagic fish school sightings made by spotter pilots, who provide the sighting logs to the SWFC after radioing the information to fishermen. The reliability of the aerial spotter data for estimating variations in Pacific mackerel distribution and availability was evaluated using commercial landings data compiled by the California Department of Fish and Game.

Satellite derived maps of sea surface temperature (SST) and phytoplankton concentration (CHL) were used to define oceanographic conditions in the Bight during the study. The SST maps stemmed from thermal radiances measured by infrared sensors on the NOAA-7 satellite and the CHL maps were produced from spectral radiance measurements in visible wavebands from the NASA Nimbus-7 Coastal Zone Color Scanner.

Results of visual image and statistical analyses indicate that the distribution of Pacific mackerel in autumn 1981-85 was restricted to "aged" upwelled waters extending into the Santa Barbara Channel from a plume of water flowing southward off Pt. Conception. These waters had a relatively cool temperature and high pigment concentration, with mean SST values between about 15°C-16°C and mean chlorophyll values greater than 0.5 mg m^3.

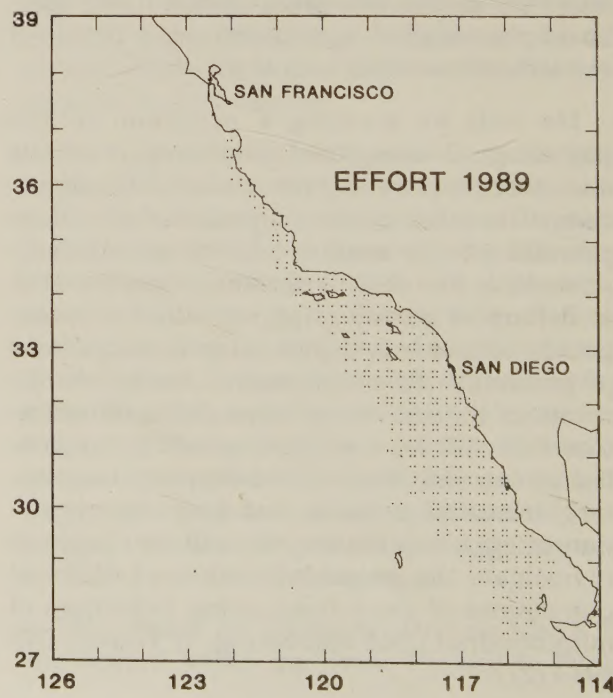
The plume of relatively cool and high pigment water flowing off Pt. Conception appears to have significant biological implications in the Southern California Bight. In addition to affecting the distribution of Pacific mackerel, it has been shown to limit the northern and offshore extent of northern anchovy (Lasker, Pelaez and Laurs 1981; and Fiedler 1983). The interannual variability in albacore tuna migration and availability in the Southern California Bight are also believed to be related to the strength and position of this oceanic frontal zone (Laurs, Hess and Svejkovsky, in preparation). (R. Laurs, FTS 893-7086)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Relative Abundance of Anchovy From Aerial Survey Data Improves Precision of Biomass Estimates From Stock Synthesis Model

The Center has used a stock synthesis model (SSM) to monitor anchovy biomass since 1986. The SSM uses all available time series of relative biomass estimates and age composition data to estimate anchovy biomass. Presently, the only available time series are the historical egg production index (an index of spawning biomass based on CalCOFI plankton samples) and age composition data from the Mexican reduction fishery whereas in past years other measures of abundance, egg production estimates and sonar surveys were available. To compensate for the lack of data and the resulting low precision, additional low cost indexes of anchovy abundance are being sought.

In 1962, James L. Squire of the SWFC began a pelagic resource monitoring program using sightings of fish schools made by pilots who locate fish for the commercial purse seine fleet off central and



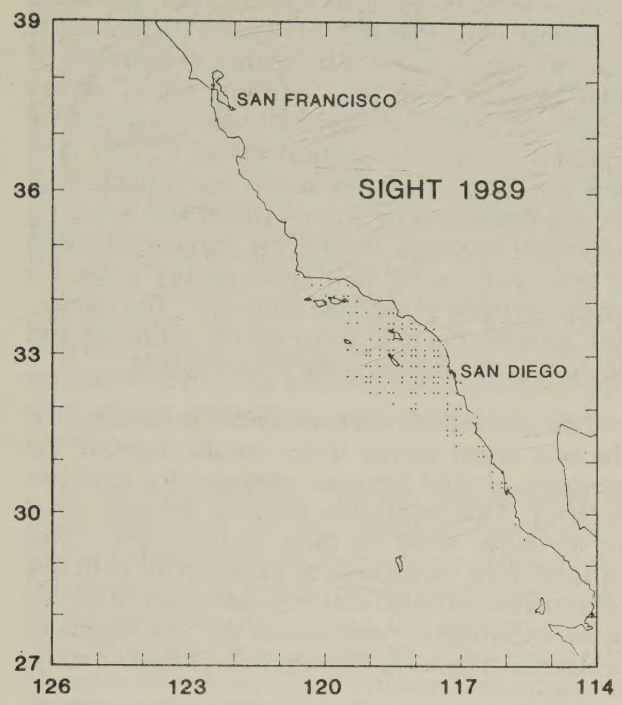


Figure 1. Aerial survey in 1989: 1a) area covered by all flights, and 1b) area where anchovy were sighted. Each dot represents the upper right hand corner of an aerial survey block.

southern California (Figure 1). Flight logs obtained from the pilots include sighting and tonnages of schools of many fish species and some marine mammals. These data are inexpensive to collect, but are difficult to interpret because they are not systematic observations. The distribution of flights among areas, season, time of the day (day/night), and pilots differ greatly among years. To account for the bias that might result from this variability, Nancy Lo derived a new index of relative abundance based on a general linear model (GLM).

Model

The index of relative abundance of northern anchovy (or other pelagic species) during each year is expressed in terms of tons of fish sighted by pilots per unit area where the unit is a 10" long. x 10" lat. block of sea surface, and the total number of distinct blocks entered by pilots (a measure of the area of the stock):

$$A = R \times Q \qquad (1)$$

where A is the index of relative abundance, R is tons of fish sighted per block and Q is the total number of blocks.

Stock density (tonnage per block) was estimated from the product of tons per block from the positive flights (flights in which pilots sight anchovy in one or more blocks) and the ratio, blocks entered during positive flights divided by total number of blocks entered on all flights.

$$R = R_p \times P \qquad (2)$$

where R_p is tons of fish per block for positive flights and P is the ratio.

The tons per block for positive flights (R_p) and the proportion positive (P) were estimated using GLM procedures.

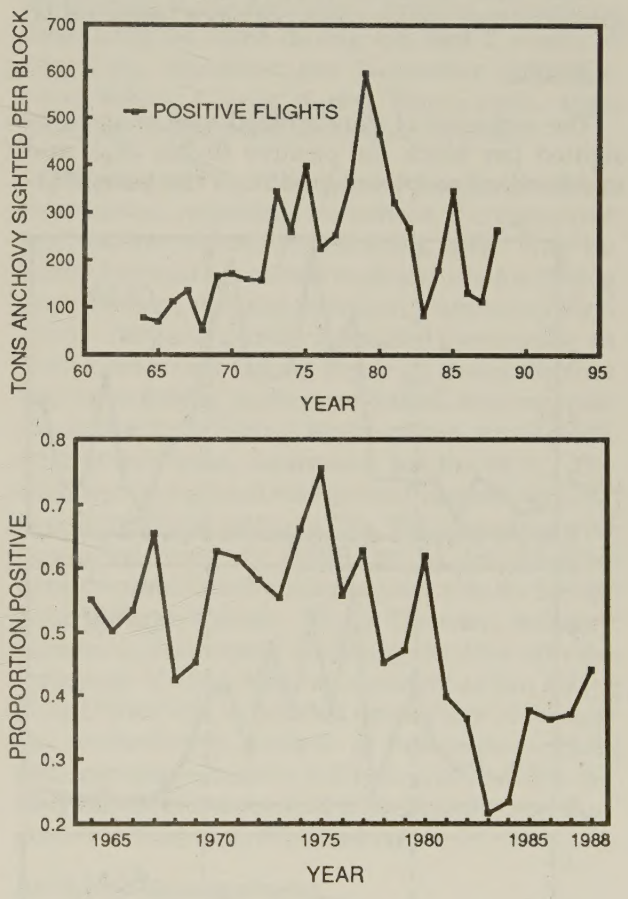


Figure 2. 2a) Standardized tons of anchovy sighted per unit area (10" long. x 10" lat. block) for the positive flights, and 2b) standardized proportion of blocks that were entered during positive flights

Five factors were included in the models with the main effects being year, pilot, region, season, and day/night. A number of the first order interactions were included as well. The logarithm of tons of fish per block for the positive flights (R_p) was expressed as:

$$\ln(r_{p,ijk}) = \beta_0+\Sigma_{ij}\,\beta_i\,x_{ij}+\Sigma_{ii'},\,\alpha_{ii'},z_{ii'},+e_{ijk} \qquad (3)$$

where r_p is the tons of fish per block for a particular year, location, season, time of day and pilot, β_0 is the mean for reference year (1963), reference location (area 2), reference season (spring) at reference time of day (night) and the reference pilot (pilot 1), β_i is year effect (i=1), pilot effect (i=2), season (i=3), location (i=4), and day/night (i=5), x=1 or 0, the dummy variable for a particular year, location, season, time of day and pilot, $\alpha_{ii'}$ is the interaction terms for season, location and day/night, z=1 or 0, the dummy variable for a particular interaction, and e is the error term.

The GLM used for proportion positive was similar to that used for tons per block (equation 3).

Results

The estimates of standardized tons of anchovy sighted per block for positive flights (R_p), and standardized proportion positive (P) for years 1964-1988 for area 2 in spring by reference pilot 1 in night time are given in Figure 2. In Figure 3 the new aerial survey biomass index is compared to estimates of total biomass from SSM (without aerial survey index) and to the aerial survey index developed by Squire (a catch-per-unit-effort model, CPUE). The new aerial biomass index seems less variable than the one developed by Squire, which was based on only night sightings. In addition, the general trends in abundance in the new aerial survey index are similar to those of the SSM estimates. The correlation between the new aerial survey estimates and biomass estimates using the SSM was 0.64.

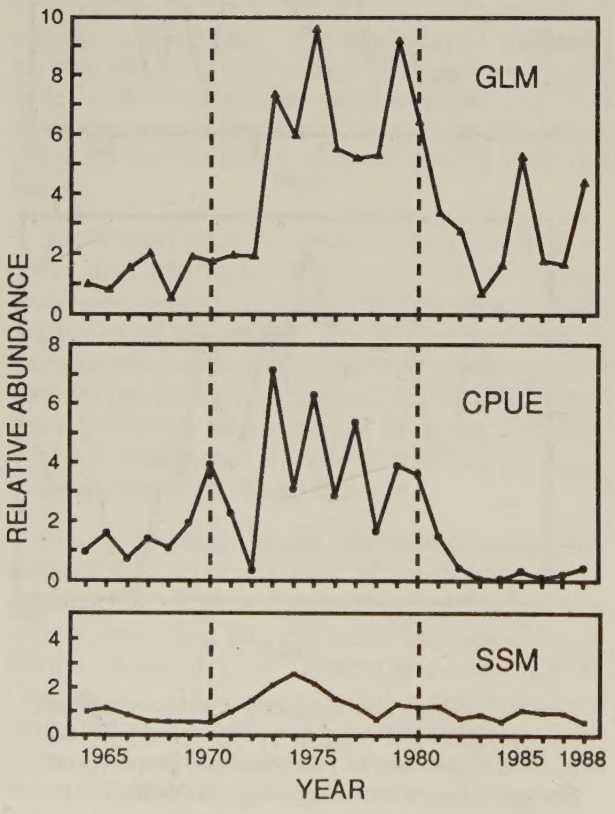


Figure 3. Relative abundance of northern anchovy using stock synthesis model estimates of total biomass without aerial survey index (SSM), a catch-per-unit-effort index based on night time aerial survey data (CPUE) and the new index based on GLM models for aerial survey data. Each time series was standardized by dividing each value by the value

Two simulations were conducted to determine if the new aerial survey index would improve the precision of SSM biomass estimates for northern anchovy. One simulation included the new aerial survey index while the other run did not. Comparison of the coefficients of variation for both sets of estimates indicated that inclusion of aerial survey index improved the precision of the SSM estimates of biomass (Figure 4). The new index based on aerial survey appears to be a cost effect index for monitoring abundance of northern anchovy stock. (N. Lo, FTS 893-7123; L. Jacobson, FTS 983-7117)

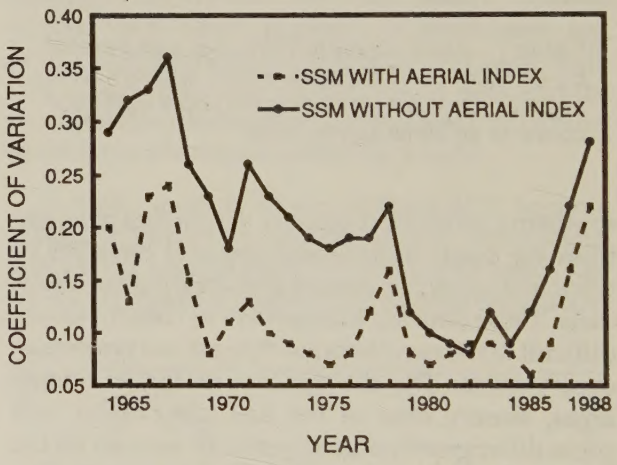


Figure 4. Coefficient of variation of estimates of biomass of anchovy using a stock synthesis model with and without standardized estimates from aerial survey.

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Capacity Utilization in the U.S. Tropical Tuna Purse Seine Fleet

Samuel Herrick, Jr. and Dale Squires, industry economists, have completed an analysis of capacity utilization (CU) in the U.S. tropical tuna purse seine

fleet. Herrick and Squires define CU as a measure of the extent to which a given stock of capital is put to use within an industry. In this context CU can be expressed as the ratio of actual to potential output or production, where potential output is interpreted as the optimum output from an economic point of view. CU measures are of interest since the degree to which a stock of capital is being utilized indicates the potential for investment, or disinvestment, within an industry. Because it is based on a fixed capital stock, capacity utilization is inherently a short-run concept. Therefore, measures of capacity utilization should be based on the short-run objectives of the individual firms comprising the industry.

In fishing industries, revenue maximization is often considered the appropriate short-run objective of fishing firms since during the course of the fishing season all inputs may be quasi-fixed (fixed in the short-run, variable in the long-run) while outputs are the firms' decision variables. Given this objective Herrick and Squires describe an approach that recovers measures of capacity utilization from the firm's multi-output revenue function. They then use this approach to analyze capacity utilization in the U.S. tropical tuna purse seine fleet. The analysis examines the impact of limiting yellowfin tuna catches on capacity utilization in the U.S. tropical tuna fleet and the resulting incentives for disinvestment in, or even exit from the fishery.

Under 1987 resource stock conditions and exvessel prices, CU for the U.S. tropical tuna fleet operating in the eastern tropical Pacific Ocean (ETP) was estimated to be 1.230. This value indicates that actual output was greater than long-run equilibrium output, and therefore an incentive for fleet expansion existed. Results from the analysis were also used to gauge the impact on the U.S. tropical tuna fleet of limiting its ETP yellowfin catch. Restricting the ETP yellowfin catch to 80 percent of the actual catch for 1987 resulted in CU decreasing by an estimated 90 percent. Based on the methodology and assumptions of the revenue function approach and data from the 1987 fishery, any constraints on the yellowfin catch will exert extremely strong contractive pressures on the U.S tropical tuna fleet operating in the ETP. (S. Herrick, FTS 893-7111; D. Squires, FTS 893-7113)

Southern California Sportfish Economic Survey Completed

The Southern California Sportfish Economic Survey has been completed. The survey was targeted at sport anglers residing in eight southern California counties (Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura). The survey data will be used to estimate the level of activity and economic value of the recreational saltwater fishery in southern California.

The survey involved a two-stage sampling procedure: 1) a random telephone canvass of southern California households to identify individuals who had gone saltwater fishing in the previous 12 months, and 2) a follow-up mail questionnaire.

Included in the telephone survey were questions regarding household participation in finfishing and shellfishing in the previous 2 months. Telephone canvassing occurred during the first 2 weeks of May, July, September and November of 1989 to cover fishing activity during March-April, May-June, July-August and September-October.

Respondents to the mail questionnaire provided information regarding household demographics (e.g., income, ethnicity, education, age). They estimated annual household expenditures for fishing gear, licenses, and boat purchase, maintenance and repair. They also provided detailed information on their most recent fishing trip (e.g., travel distance and time, fishing mode, area fished, trip expenditures, time spent fishing, target species, actual catch, type of bait used, motivation for the trip). The number of completed mail questionnaires was 1,757 and the response rate was 75%. The contractor who conducted the survey, HBRS, Inc., has provided the data, documentation and a final report to the Southwest Fisheries Center. Cindy Thomson, industry economist, is currently analyzing the data with the assistance of Mike Malone, a student at San Diego State University. A detailed description of the survey methodology, analysis of non-response bias, and descriptive statistics will be available within the next month in the form of a Technical Memorandum. (C. Thomson, FTS 893-7116)

Anchovy Management

On April 4, Larry Jacobson attended a meeting of the Pacific Fishery Management Council (PFMC) in Eureka, California, as a member of the Anchovy Fisheries Management Plan (FMP) team. At the meeting, the Council adopted two amendments to the current FMP for anchovy. The first amendment establishes an unconditional 7,000 metric tons (t) optimum yield (OY) for the reduction fishery when spawning biomass is below 300,000 t. The second amendment involves a definition of overfishing for anchovy that is necessary to make the FMP com-

patible with recently revised guidelines for National Standard 1 of the Magnuson Act. The amendment has been forwarded to the Department of Commerce for approval. (L. Jacobson, FTS 893-7117)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

BIOLOGY ASSESSMENT PROGRAM

Molecular Analysis of mtDNA Types in Exploited Populations of Spinner Dolphins

Because of the importance of the question of cetacean stock identity to the International Whaling Commission's Comprehensive Assessment efforts, a workshop was convened to deal with the subject. Investigators working on cetacean genetics as well as experts in population genetics met at the SWFC in La Jolla on September 27-29, 1989. Their charge was to review past and current studies on the genetic and biochemical analysis of tissue samples collected by biopsy sampling and other means. Papers were presented and were collected to be published in a special issue of the International Whaling Commission.

Andrew Dizon (fishery biologist, SWFC), Šárka Southern (molecular biologist), and William Perrin (senior scientist, SWFC) recently submitted a final revised version of a manuscript to the International Whaling Commission describing their work on mtDNA analysis of spinner dolphin stocks. Stock structure of geographic forms of the spinner dolphin (*Stenella longirostris*) in the ETP is a conservation issue. These animals are incidentally killed during yellowfin tuna purse seining by U.S. and international fleets, and mortality quotas apportioned by stock have been established by U.S. legislative action.

Four management stocks of spinner dolphins in the ETP are currently defined on the basis of morphology and geographical distribution. However, recent work proposes that two of the stocks (the northern and southern "whitebelly" spinners) comprise a broad zone of hybridization or clinal integration between the neighboring endemic "eastern" spinner and the more typical spinners residing to the west and around the world in the tropics. If this hypothesis is true, evidence of current or recent gene flow between the neighboring "stocks" should be apparent. To investigate this, they conducted a molecular analysis of maternally-inherited mitochondrial DNA (mtDNA) extracted from livers of 151 spinner dolphins from the ETP and 13 spinner dolphins from the Timor Sea. They also analyzed mtDNA from 10 spotted dolphins from the ETP. Liver mtDNA from each animal was digested with six restriction enzymes to deduce the individual mtDNA haplotypes. Genetic distances were then inferred within the sample pool by comparison of the individual mtDNA haplotypes in a pair-wise fashion.

Results suggest that: 1) The morphologically distinct eastern and whitebelly spinner dolphins are not genetically distinct at the level of resolution of our analysis. They found no concordance of mtDNA haplotype with either the stock type of the school or individual morphology. The mean between-form distance was not significantly different from the two mean within-form distances. Thus, introgression (movement of mtDNA to some degree independently from chromosomal DNA) is likely occurring (or has recently occurred) and significant genetic interchange can be inferred. 2) Mean within-school mtDNA diversity varied from school-to-school, and no clustering of certain haplotypes within specific schools was detected. 3) Timor Sea spinners and the spotted dolphins have unique mitochondrial genotypes likely characteristic of their geographic and genetic separation in the case of the spinner dolphins and their species-level separation in the case of the spotted dolphins. These findings reinforce the morphologically-based hypothesis of non-uniqueness of the whitebelly form and suggest that relatively more emphasis should be placed on conservation of the endemic and presumably locally adapted eastern form. (A. Dizon, FTS 893-7089)

Marine Mammal Stranding Program Initiated

The SWFC Stranding Program was initiated in order to collect biological and mortality data from marine mammals that wash ashore along the San Diego County coastline. During the last 2 weeks of April, at least 52 pinniped strandings had been reported. All the animals had stranded on a relatively small stretch of coastline, from Coronado to Imperial Beach. This episode began suddenly. Over the first 5 days, 15-20 pinnipeds were found. The

evidence to date suggests incidental mortality in fishing gear. The first batch of about six animals were reportedly shot, but the animals were washed away or removed from the beach before any of the stranding program personnel could examine the carcasses.

Other carcasses were examined on the beach by Kelly Peltier and Jerry Kashiwada (biologists, SWFC). A number of them were missing their heads, and at least one had its head cut off, while for most of the others much of the tissue around the head was abraded off probably when they were in the surf. Four animals were necropsied (one harbor seal and three California sea lions). One of the animals examined had injuries that could have been attributed to bullets, but upon further investigation, these were assumed to be gaff marks presumably made by fishermen. In addition, three of the animals examined had eaten shortly before dying and apparently died suddenly. One sea lion was found with an 8 inch mesh gillnet wrapped around its neck. It also carried an orange flipper tag, which indicates that it had previously been rehabilitated and released.

A number of organizations are looking into the causes of this incident. A San Diego County veterinary pathologist is planning to necropsy any fresh animals that are found in order to determine possible causes of death. The California Department of Fish and Game stated that there were 6-8 halibut boats operating out of San Diego. Aleta Hohn (fishery biologist, SWFC) has concluded that this unusual number of strandings could possibly be associated with the close proximity of halibut fishing nets to the shore (which apparently attract the animals) combined with currents which allow the animals to be pushed ashore rather than out to sea. To date there is no estimate of incidental marine mammal mortality in association with gillnets. This summer observers will begin to collect data aboard gillnet vessels in order to better assess fishery interactions. (A. Hohn, FTS 893-7088)

Management Of ETP Dolphins - Observer Coverage

SWFC Statistician, Cleridy Lennert, has reexamined the foreign observer coverage requirements and the statistical methods used in the 1989 determination on comparability of mortality rates. In 1989 it was determined that 33 percent observer coverage for fleets with 10 or more vessels, 50 percent observer coverage for fleets with 5 to 9 vessels, and 100 percent coverage for fleets with 1 to 4 vessels would produce a mortality rate that was statistically reliable.

Although observer coverages of 33% and 50% are statistically acceptable to determine comparability of average mortality rates between the U.S. fleet and a foreign fleet, there are several benefits in raising the level of coverage. First, increasing the rate of observer coverage improves the accuracy of the overall estimates of the mortality rates by reducing the uncertainty due to any "observer effect." Increased observer coverage also provides a more accurate basis for determining the proportion of eastern spinner dolphins and coastal spotted dolphins in the catch. Estimates of these proportions are required by U.S. law (MMPA as amended in 1988). Higher rates of coverage also allow for a quicker implementation of a vessel operator performance system, which is required under U.S. law. The Service is currently trying to arrange with the State Department and the Inter-American Tropical Tuna Commission for funding to allow for increased rates of observer coverage. (C. Lennert, FTS 893-7074)

FISHERY DEPENDENT ASSESSMENT PROGRAM

TOPS Simulates Research Vessel Estimates of Dolphin School Abundance

Elizabeth Edwards and Pierre Kleiber, SWFC fishery biologists, have completed a set of mathematical simulations testing the efficacy of ongoing MOPS (Monitoring Of Porpoise Stocks) cruises using line transect surveys of dolphin abundance in the eastern tropical Pacific (ETP) Ocean. Their simulations used the TOPS (Tuna-vessel Observer Program Simulator) model, which they had developed originally in order to simulate the process of "dolphin fishing" by tuna purse seiners in the ETP. The only difference between the model used for MOPS data (RV/TOPS) and the earlier version (TV/TOPS) is that the 75 tuna vessels in the original model were replaced by two survey ships. These two survey vessels represent the vessels used currently during MOPS.

The model simulates the movements of dolphin schools and vessels in a 1200 x 1200 nm area characterized by non-random spatial distributions of dolphin schools. The three basic components of the RV/TOPS model are 1) the environment, 2) the dolphin schools, and 3) the two research vessels. Vessels move continually without interruption along pre-determined cruise tracks at an assumed speed of 8.3 knots. Sightings occur only during daylight hours, i.e., during alternate 12 hour periods. This provides about 100 nm search effort

per vessel per day, during those days when the vessels are inside the simulated area.

The effects of trackline length, environmental topography, and environmental stochasticity were investigated by estimating dolphin school abundance under various combinations of values for each factor. Each combination of factor conditions was replicated 100 times. The results indicate that MOPS survey procedures are adequate to provide acceptably accurate and precise estimates of relative dolphin abundance despite the realities of limited effort and environmental non-randomness. Given the most likely set of conditions (2500 dolphin schools, 7000 nm trackline searched), RV/TOPS estimates of dolphin abundance were relatively unbiased (less than 5 or 10%, depending on the measure selected for bias) with acceptable coefficients of variation (15-20%).

RV/TOPS estimates of dolphin school abundance were little affected by environmental conditions or starting positions. This was expected, as the random nature of the cruise tracks should provide estimates that are insensitive to non-randomness in the distribution of dolphins. This differs markedly from earlier results in the TV/TOPS simulations, which showed that small-scale non-random spatial clustering of dolphin schools can seriously bias estimates of school density derived from data collected during non- random searching by commercial purse-seiners.

Edwards and Kleiber are encouraged by the results for point estimates of school abundance, and for estimates of trends in school abundance. By implication, a series of estimates from successive years should reflect real changes in school abundance regardless of whether changes in environmental conditions have caused changes in the spatial distribution of schools.

The results of the RV/TOPS simulations apply only to estimates of dolphin school abundance. Several other estimates (school size, species proportions, area inhabited), required for deriving estimates of population density, have not been addressed. Incorporating these components would increase the variability (with concomitant decrease in precision) for the population estimates. These results imply that the current sampling level for MOPS is just barely adequate for approaching or achieving desired levels of accuracy and precision in estimates of relative abundance of dolphins.

Additionally, these simulations did not incorporate a number of factors that are known or suspected to affect line transect estimates of dolphin school abundance. In the real world, school sightability can be adversely affected by environmental factors such as weather conditions (e.g., clouds, rain, wind speed, swell direction and height) and sun angle, as well as by survey characteristics such as observer experience and sighting platform geometry and stability. The degree to which these factors may be affecting estimates derived from the research survey data cannot be evaluated on the basis of the results presented here. Further simulations incorporating some of these effects are currently underway but not yet completed.

A third major difference between these simulations and conditions pertaining to the MOPS surveys is that these results were generated using theoretical environmental topographies. These topographies encompass the range of spatial clusterings seen for dolphin schools in the ETP, but are regular arrays rather than a topography based on oceanographic data per se. However, it is unlikely that incorporating a more exact topography would change significantly the mean estimate or its statistical characteristics. Individual estimates within sets of replicates would doubtless change, but given the range of environmental types tested here, if changes in estimates were going to occur in response to changes in environmental conditions, they would have done so in the simulations already completed.

The RV/TOPS model showed that reasonably precise and accurate estimates of dolphin school abundance could be derived using current sampling levels, even under conditions of relatively limited sampling effort, environmental bias, and strongly non- random, nonstationary distributions of dolphin schools.

Simulations results verify theoretical assertions that adequate estimates of abundance for non-randomly distributed, non-stationary (but relatively slowly moving) objects can be derived from line transect surveys provided transects are chosen randomly with respect to the sighted objects, biases remain consistent, sampling artifacts are minimal, and provided sampling levels are sufficient. As sampling levels decrease, violations of assumptions become increasingly important. (E. Edwards, FTS 893-7099)

COASTAL MARINE MAMMAL PROGRAM

Proposed Management Framework For Marine Mammals

SWFC Research Analyst Jay Barlow has put together a proposal which will be used in preparation for the 1992 reauthorization of the Marine Mammal Protection Act. Believing that too much complexity will likely be a detriment to the implementation of any proposal, he has tried to derive a single, simple equation which sets the allowable harvest from a marine mammal population. This is illustrated in Figure 1. Because safety factors are built in and because all harvests are proportional to the population size, this approach will be robust to problems in estimating the status of populations.

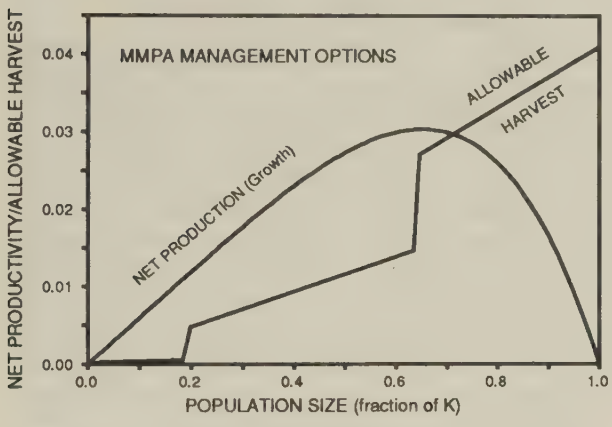


Figure 1. Proposed management framework for marine mammals. The net productivity (or growth rate) of a population is expressed as a parabolic function of population size. The allowable harvest is given by the diagonal lines representing 10%, 50%, or 90% of the maximum net productivity (depending on the status of the population relative to K).

This proposal incorporates safety factors at three levels. First, there is an explicit allocation factor built into the equation for allowable take. Second, a minimum estimate of population size is used in place of the mean estimate of population size. Finally, animals from populations that are spatially disjunct should be assumed to belong to separate stocks, unless morphological differences exist, or unless it is shown that the rate of interchange between those areas is greater than 1% per year.

In Barlow's scheme, allowable take depends on the status of the population. Status is classified into one of three categories. Classification of status will be made based on best available information with no explicit safety factor. First, a population is severely depleted if it is below 20% of its mean equilibrium population (K). Second, a population is depleted if it is above 20% of K but is below its maximum net productivity level. Finally, a population is acceptable if it is above its maximum net productivity level. If population status is unknown, then it is assumed to be severely depleted. If population status is uncertain, but known to be above 20% of K, then the population is assumed to be depleted. Mean equilibrium population is defined as the average population size that would be expected in the absence of any human factors. If the maximum net productivity level cannot be estimated, it will be assumed to be 65% of mean equilibrium population.

Allowable take, AT, is defined as being less than or equal to the product of an allocation factor times the maximum allowable take rate times the minimum population size:

$$AT \leq \text{Allocation} \times R_{MAT} \times N_{min}.$$

The definition of the above terms can vary depending on the status of the population and the availability of information.

The allocation factor above depends only on the estimated status of the population. If the population is severely depleted, the allocation factor is 0.1. If the population is depleted, the allocation factor is 0.5. If the population is at acceptable levels, the allocation factor is 0.9.

The maximum allowable take rate, R_{MAT}, is defined as the maximum net productivity rate of a population. This is the maximum net growth of a population divided by the population size that gives that growth rate. If the maximum net productivity rate has not been measured, it is defined as the greatest net productivity rate that has been previously measured. If net productivity has never been measured, it is defined as 0.06 for pinnipeds and 0.02 for cetaceans.

The minimum population size, N_{min}, is defined as the lower 95% confidence level of the population abundance estimate. If statistical estimates of abundance are not available, it is defined as a minimum count of the animals in the population. If a minimum count is not available, the maximum allowable take is zero.

Further research into and application of this model, will elaborate its behavior given a variety of possible errors in the estimation of status or of population parameters. (J. Barlow, FTS 893-7178)

HONOLULU LABORATORY

Honolulu, Hawaii

PELAGIC RESOURCES INVESTIGATION

Boggs Presents Longline Paper in Azores

Fishery Biologist Christofer H. Boggs presented "Longline Research on Tuna and Marlin" at the 10th Annual *Semana das Pescas* or Fisheries Week of the Azores, a conference held in Horta, Faial, Azores, March 12-16, 1990. The *Semana das Pescas* meeting--which was attended by about 300 Azorean commercial fishermen, along with businessmen, administrators, and fisheries experts--brought together fisheries experts from around the world to address problems in fisheries development, regulation, trade, aquaculture, and marketing as well as fisheries science.

Boggs' paper was particularly well received because of local interest in fishing for bigeye tuna, *Thunnus obesus*. Azorean fishermen have been experimenting with longline gear during the winter, when the surface fishery for skipjack tuna, *Katsuwonus pelamis*, and bigeye tuna is inactive. Their efforts have met with little success, so the fishermen were very interested in Boggs' description of the measurement of fishing depth in relation to catch rates. The audience was astonished to hear about the prices (average, $3.00/lb) for bigeye tuna in Hawaii compared with prices (average, $0.10/lb) in the Azores, where fresh, sashimi-quality bigeye tuna, weighing 100-200 pounds, are used for canning!

A number of interesting papers were presented at the meeting. Kim Holland of the University of Hawaii discussed the sonic tracking research on tunas that is being conducted jointly with NMFS Southwest Fisheries Center's Pelagic Ecosystems Program. Other highlights included an excellent paper on the Azorean limpet (*Patella* spp.) fishery, which is similar to Hawaii's "opihi" (*Cellana* spp.) fishery and is now closed because of overexploitation; a paper on the Azorean oceanographic environment, which may have a strong bearing on local tuna availability; and a paper comparing the fish auction systems in New England with those in the Azores. In addition to the formal presentations, there were training sessions and technical exhibits.

Boggs' travel-related expenses were funded by the Azorean Government. (C. Boggs (808) 943-1222)

Ageing Studies Conducted on Dolphin Fishes

Ageing studies on mahimahi, *Coryphaena hippurus*, and the pompano dolphin, *C. equiselis*, a smaller congener of mahimahi, were recently completed by James H. Uchiyama, fishery biologist. The studies examined the increments of otoliths to estimate the growth rate of larval dolphin fishes in the wild.

Mahimahi is a pelagic species important to the sport and commercial fisheries in Hawaii. For over a decade, it has been studied as a species for mariculture. In laboratory tanks, pairs of mahimahi have spawned every other day regardless of the season for as long as they were paired, which lasted as much as 6 months. Their spawning frequency in the wild is not known.

Larval and postlarval mahimahi collected with the NOAA Ship *Townsend Cromwell* in April and September 1988, were aged by counting daily growth increments from otoliths. Hatching dates were estimated by subtracting their estimated ages plus 1 day from the date of capture. When the hatching dates were plotted together, spawning appeared to occur throughout both months but was more prevalent when the moon is waning to the new moon. Similar spawning behavior was observed for the pompano dolphin. However, spawning activity seems to be concentrated around the new moon, which occurred on September 11, 1988.

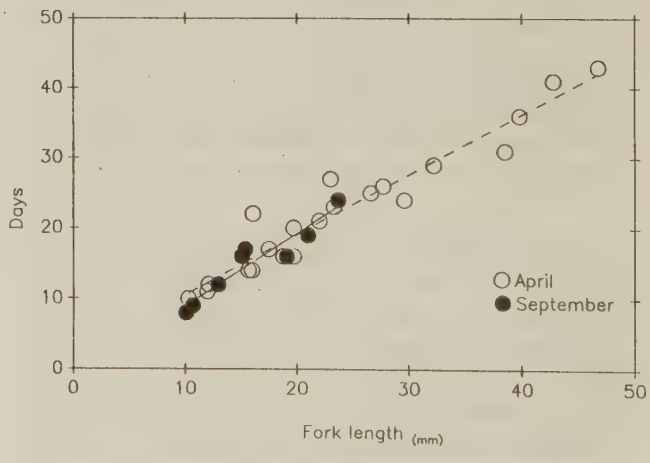


Figure 1.--Growth of postlarval *Coryphaena hippurus* in April and September 1988.

Sea surface temperature differed by 2°C from April (24°C) to September 1988 (26°C). Because postlarval dolphins are neustonic, sea surface

temperature could affect growth rates. However, growth rates for postlarval mahimahi in April and September (Figure 1) were not significantly different ($P>0.1$). Likewise, growth rates for postlarval pompano dolphin during the same time period (Figure 2) also were not significantly different ($P>0.1$).

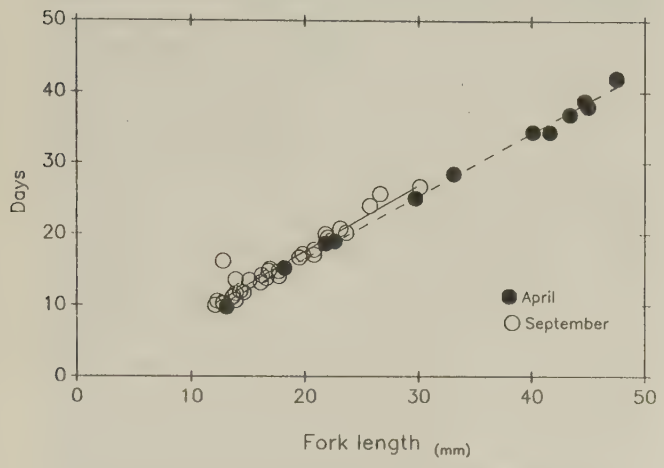


Figure 2.--Growth of postlarval *Coryphaena equiselis* in April and September 1988.

The growth rate of larval (<11 mm total length) mahimahi was 0.78 mm per day, whereas postlarval (10-45 mm fork length (FL)) mahimahi grew 1.07 mm per day. Postlarval (10-47 mm FL) pompano dolphin grew 1.04 mm per day. (J. Uchiyama (808) 943-1220)

Watson Completes Ph.D. Dissertation

Cheryl Watson, a graduate student in the Department of Physiology, John A. Burns School of Medicine, University of Hawaii, completed and successfully defended her Ph.D. dissertation, "An analysis of calcium dependent proteolysis in yellowfin tuna (*Thunnus albacares*) muscle." Her dissertation research included experiments conducted at the NMFS Honolulu Laboratory's Kewalo Research Facility and was supported by a grant from the State of Hawaii to the Pacific Ocean Research Foundation (Kailua-Kona, Hawaii) and funding from the University of Hawaii Sea Grant Program.

Yellowfin tuna muscle is subject to a form of deterioration known in the commercial market as "burnt tuna." This condition substantially reduces the retail value of tunas intended for raw consumption as sashimi and costs Hawaii's fishing industry millions of dollars in lost revenue each year. Understanding the causes of the problem and developing techniques for its prevention are therefore critical to this segment of the fishing industry. Previous work on burnt tuna has suggested that it is caused by a calcium-activated neutral protease (calpain) that produces a limited proteolysis of the noncontractile myofibrillar proteins.

Watson's dissertation research covered two areas. The first constructed a working cellular definition of the whole animal condition identified as "burnt tuna." Cellular differences in burnt tuna were quantified microanatomically and biochemically. Electron microscopy studies showed that there was a significant loss of Z-disc integrity and an increase in intracellular edema in burnt tuna. Biochemical analysis, using sodium dodecyl sulphate polyacralamide gel electrophoresis, showed that burnt tuna had a significant loss of two specific proteins [46 and 42 kilodalton (kD) molecular weight]. Both studies confirmed that burnt tuna is a specific and limited proteolysis of both structural and contractile proteins.

The second part of the dissertation research tested the hypotheses that burnt tuna is caused by calpain, which becomes activated because of an increase in intracellular free calcium, and that calpain's proteolytic activity is accelerated by catecholamines (epinepherine and norepinepherine). Isolated myofibrils incubated in saline containing purified calpain showed proteolysis of the 46 kD and 42 kD proteins that characterize burnt tuna, as well as limited proteolysis of other myofibrillar proteins. This occurred at all three pH's (5.5, 6.8, and 7.5) tested. Incubations of whole yellowfin tuna muscle cells in buffered saline containing either calcium or EDTA (a calcium chelator) resulted in a generalized, nonspecific proteolysis. Pretreatment of the incubated whole cells with the isoproterenol sulfate (a drug that mimics the effect of catecholamines) did not induce a more rapid specific proteolysis of the 46 kD and 42 kD proteins. Instead, a more rapid, generalized proteolysis occurred.

Exploratory experiments, using either a metabolic stimulator (pyrophosphate) or a metabolic inhibitor (iodoacetate), suggested that the proteolysis occurring during incubations of whole cells was related to the quantity of glycogen present in the cell. A revised comprehensive theory of the etiology of burnt tuna--which included the effects of pre-mortem cellular energy reserves on the susceptibility of certain tunas to become burnt--was developed to provide directions for future research.

Copies of Watson's dissertation will be deposited at the libraries of the Honolulu Laboratory and the La Jolla Laboratory. (R. Brill (808) 943-1234)

Paper Published on Ventilation Volume in Swimming Tunas

The "Measurement of ventilation volume in swimming tunas" by David R. Jones, Richard W. Brill, Pat J. Butler, Peter G. Bushnell, and Mark R. A. Heieis, was recently published in the Journal of Experimental Biology, 1990, 149:491-498. The first direct measurements of ventilation volume ($\dot{V}_g$) in restrained fish were obtained in 1938 by L. Van Dam, who used a rubber membrane, stretched around the fish's head, to separate inspired and expired water. In the ensuing 50 years, modifications of this technique have been widely applied in studies of fish physiology. Current methods for measuring the $\dot{V}_g$ in swimming fish are indirect and require accurate determination of inspired (P_{IO2}) and expired (P_{EO2}) oxygen tensions and of oxygen consumption ($\dot{V}_{O2}$). While P_{IO2} can be easily determined, measurement of P_{EO2} can be troublesome, and for fish swimming in a large volume of open water, establishing the V_{O2} is next to impossible.

An alternative method has been described by E. D. Robin and his coworkers for direct measurement of $\dot{V}_g$ in restrained fish using a bolus injection (i.e., Hamilton-Stewart) dye dilution technique, but it is not practical for use with swimming animals. The paper by Jones et al. (1990) details a continuous infusion dye dilution technique suitable for direct measurement of $\dot{V}_g$ in swimming fish. The technique was used to measure $\dot{V}_g$ in swimming kawakawa, Euthynnus affinis; yellowfin tuna; and skipjack tuna.

The highest $\dot{V}_g$ recorded was 6.05 L kg^{-1} min^{-1} in a yellowfin tuna (mass = 1.075 kg) swimming at 2.29 BL s^{-1}, and the lowest was 1.40 L kg^{-1} min^{-1} in a kawakawa (mass = 1.375 kg) swimming at 1.15 BL^{-1}. At low swimming speeds (<1.9 BL s^{-1}), $\dot{V}_g$ ranged from 1.4 to 2.0 L kg^{-1} min^{-1}, which is somewhat less than has been generally assumed for tunas. The $\dot{V}_{O2}$ at these swimming speeds ranged from 302 to 555 ml $kg^{-1}h^{-1}$.

Many fish ram ventilate at high swimming speeds, which suggests that the dye-dilution technique could be used for measuring $\dot{V}_g$ in other active fish besides tunas. Also, the highly pulsatile nature of water flow at the anterior end of the buccal cavity of fish breathing normally indicates that good dye mixing could be achieved even in resting fish. Consequently, this technique could be used for both resting and active fishes. (R. Brill (808) 943-1234)

FISHERY MANAGEMENT RESEARCH PROGRAM

Lobster Fishery Research and Management Meetings Held

Lobster fishery monitoring and research were discussed at a February 28, 1990 meeting with members of the lobster industry and scientists from the Insular Resources Investigation and the Fishery Management Research Program (FMRP) of the Honolulu Laboratory. Individuals from the lobster industry included the captains from 7 of the 10 vessels currently active in the fleet. A number of topics for discussion were introduced by the Honolulu Laboratory scientists: the 1989 landings, stock assessments, vessel performance, and fleet-wide activity; research into ghost-fishing and larval movement; and monitoring through logbooks and revenue reports. Industry participants had raised concerns in late 1989 about the decreasing catch rates and the apparent declining size of spiny lobster, *Panulirus marginatus;* the continued depression of catch rates of slipper lobster, *Scyllarides squammosus;* and the potential for dramatically increased fishing effort by new entrants into the fishery during 1990.

Another meeting was held on March 15, 1990, between the Western Pacific Fishery Management Council and members of the lobster industry (captains, owners, and processors). This meeting centered on industry opinions concerning the means for reducing fishing effort in the NWHI fishery. Although an apparent majority of the active vessel owners and captains at the meeting supported some sort of limited entry or effort restriction, a number of owners were still clearly opposed to such restrictions. One proposal was to restrict the entry of any other vessels into the fishery while also reducing the number of traps carried by existing permit holders. Council member Frank Farm and Council staff Dorothy M. Lowman indicated that the issues discussed would be summarized for the forthcoming Council meeting on April 9 in Guam. At that meeting, there may be an announcement of a "control" date (i.e., a date after which the vessels could not be ensured entry into the fishery under any grandfathering provisions of a new limited entry plan). (S. Pooley (808) 943-1216)

Council's Plan Monitoring Teams Meet

The four plan monitoring teams (PMTs) of the Western Pacific Fishery Management Council met on March 5-9, 1990 at the East-West Center, Honolulu. The bottomfish and pelagic PMTs dis-

cussed the annual report process; the crustacean and precious coral PMTs discussed the definition of recruitment overfishing thresholds to meet NMFS Headquarters requirements for increased measures to prohibit overfishing. Also participating in this meeting were PMT members from four Pacific island areas--American Samoa, Guam, Hawaii, and the Northern Mariana Islands. The PMT's plan to meet again the week of May 8 in Honolulu to prepare an annual report for each fishery. (S. Pooley (808) 943-1216)

Swordfish Fishery Status Reported

A recent development in Hawaii's tuna longline industry is the targeting of broadbill swordfish, *Xiphias gladius*, according to Kurt E. Kawamoto, a fishery biologist and head of the FMRP's Hawaii wholesale market monitoring program.

Fishing effort directed at the broadbill swordfish increased throughout 1989--the first year several vessels within the tuna longline industry successfully targeted this species. Prior to the recent efforts, this resource was ignored because it constituted a very small percentage of tuna longline fishery landings. Exploratory fishing trips, conducted in 1989 by fishermen using monofilament longline gear at night in conjunction with light sticks and squid for bait, have shown significant swordfish concentrations within the exclusive economic zone of the Hawaiian Archipelago.

An estimated 500,000 pounds (whole weight) of swordfish were landed by 10 longliners targeting this resource on a part-time basis in 1989. Half of these longliners reportedly landed most of these fish. During the 1990 fishing season, effort by the same number of longliners (10) already has increased over last year's, with more fishing trips being directed at swordfish and more tuna longline fishing vessels experimenting with swordfish sets.

The Hawaii swordfish longline fishery processes the catch in a manner similar to the U.S. swordfish fisheries in the Caribbean and the Gulf of Mexico; each swordfish, when landed, is headed, gutted, and tailed, and its bloodline (kidney) is removed.

The fresh fish markets on the east coast of the United States are the primary destination of the longline-caught swordfish. Presently, consumption of this species appears to be relatively limited in Hawaii. The Honolulu Laboratory is attempting to monitor catches through cooperative fishermen and is developing a research program to describe the biological attributes of the fish. (S. Pooley (808) 943-1216)

Next Step in Linear Programming Completed

Laurel Kasaoka, cooperative researcher contracted by the Honolulu Laboratory, completed revising the "Linear programming model for the Hawaiian Islands commercial multi-fishery" (SWFC Admin. Rep., Honolulu, H-90-04C), which provides an extremely flexible tool for determining the allocation of fishing effort over time and space for prototypical fishing fleets in Hawaii. The model integrates changes in baseline parameters into a multitude of scenarios necessary to run a linear program model.

The report and model are being used by Ping Sun Leung of the University of Hawaii (UH) Department of Agricultural and Resource Economics and Walter Miklius of the UH Department of Economics for their project on alternative economic viewpoints for assessing commercial fisheries. (S. Pooley (808) 943-1216)

Hawaii's Skipjack Tuna Fishery in 1989 Reported

Landings of skipjack tuna (aku) caught by pole-and-line boats in 1989 are estimated to equal about 3 million pounds or 23% less than in 1988, reported Russell Y. Ito, fishery technician. Only seven boats were active throughout 1989. The average catch of aku per trip was 3,939 pounds, down only 3% from 1988; however, total catch per trip (which includes yellowfin tuna and mahimahi) was 3,981, down 11% from 1988. Size composition in 1989 was slightly above the long-term average, and 46% of the aku landed were large (15 lb). Revenue in the fishery was approximately $4.5 million, as prices increased substantially with lower landings and more intensive marketing efforts. The average price of aku was an estimated $1.49 per pound. This information will be included in an annual report on the western Pacific pelagic fisheries being compiled by Ito and Fishery Biologist Kurt E. Kawamoto. (S. Pooley (808) 943-1226)

WPACFIN Data Coordinating Committee Meets in Guam

The Western Pacific Fishery Information Network (WPACFIN) Fisheries Data Coordinating Committee held a meeting in Guam on April 9, 1990. The meeting's most significant accomplishment was in reaching an agreement on a spending plan for fiscal year 1990's "add-on budget" for WPACFIN. The additional funds will help the support staff of the central WPACFIN program, which

is based at the Honolulu Laboratory, and each of the major participating island fishery agencies in expediting the conversion to a new data processing environment. The funds will improve the agencies' abilities to meet the ever-increasing demands for information.

Other important discussion items and accomplishments of the meeting included revising some of the guidelines and operating procedures under which the committee and WPACFIN function. (D. Hamm (808) 943-1214)

Creel Survey Begins in Hawaii

The fielding of a creel survey sampling program began on the Hawaiian Island of Oahu in March 1990. The program is designed to fill many of the information gaps that exist for Hawaii's small-boat fisheries, including those who fish for recreational, subsistence, and commercial purposes. The survey is based on a stratified random sampling approach using four major and four minor access points (i.e., ports with boat ramps). Sampling is being conducted 4 or 5 days per month at three ports (one minor and two major ports) simultaneously during the daylight hours. Total participation and catch and effort data are being collected for all fishing methods used aboard small boats.

The sampling program is partially funded by a grant from NMFS to the Hawaii Division of Aquatic Resources (HDAR) and is being fielded through a contract with a local company. The Honolulu Laboratory has been involved in this project since the early design stages over 3 years ago and will continue to support HDAR and the contractor for the duration of the 1-year study. The HDAR is overseeing the project, the contractor is fielding the survey and keypunching the data, and WPACFIN is developing the data processing system and processing the data provided on floppy disks by the contractor. The WPACFIN is using a portion of the additional funds available this year to support this new and rather large project. To date, only data entry and edit routines have been developed and given to the contractor for computerizing the data. When complete, the full system will include all processing, maintenance, management, expansion, reporting, and analysis options needed to make the most of the data collected. According to HDAR officials, they would like to extend this sampling program to include the other main Hawaiian Islands in the future, if funds can be made available. (D. Hamm (808) 943-1214)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

Relationship Between California Current Temperatures and Intensity of the Aleutian Low

Surface winds associated with the Aleutian low atmospheric pressure system in the North Pacific Ocean appear to be a major influence in forcing California Current temperature variability. Fall and winter low pressure systems bring winds from the south and southwest to the coast which force warmer offshore water onshore. This creates an ocean pressure gradient more favorable to northward transport. When the northward transport along the coast is anomalously intense, warmer water will be brought into the coastal area from the south. Increased onshore transport and increased northward transport both contribute to coastal ocean warming. Positive coastal temperature anomalies may also be augmented during enhanced Aleutian low cyclogenesis by the advection of warm humid air of more southern origin over the coastal region and by the influence of northward propagating long coastal trapped waves. Oceanographer Jerry Norton is investigating relationships between indicators of seasonal Aleutian low intensity and indicators of seasonal temperature change in the northern coastal California Current.

Both the ocean temperature and Aleutian low indicators used in the correlation analysis represent interannual change or difference parameters. This means that the interannual difference value for the current year is found by subtracting the value for the previous year from the value for the current year.

$$D_n = a_n - a_{n-1},$$

where D is the interannual difference value for the nth year and a is the anomaly compared to a long-term mean. In a physical sense, this difference represents the summation of all shorter term anomaly changes for the intervening period. Each anomaly change represents the combination of physical processes occurring within the differencing interval. If changes (anomaly differences) are relatively large, they may enter into the analysis no matter when they occur during the year. However, compensations and modulations associated with the annual cycle may associate the anomaly difference

more specifically with the period in question. An important advantage of the interannual difference transform is that it tends to remove non-stationarities and trends from the data series. The importance of year-to-year changes is increased relative to lower frequencies.

In deriving the interannual difference time series, both oceanic and atmospheric data were combined into 6 month periods. The oceanic data were averaged spatially and the atmospheric pressure data were taken from a "center of action" in an analyzed field. Statistical studies have shown "centers of action" of "key areas" to be representative of much larger geographical areas. Surface barometric pressure for the center at 45°N x 165°W is highly correlated with a surrounding area of thousands of square kilometers over the north Pacific Ocean.

Available temperature values at 0, 50, 100, 200 and 300 m for the 1954 through 1986 interval were extracted from the U.S. Navy Fleet Numerical Oceanography Center (FNOC) Master Oceanographic Observation Data Set (MOODS), for the northern coastal California Current region shown in Figure 1. These temperature values were

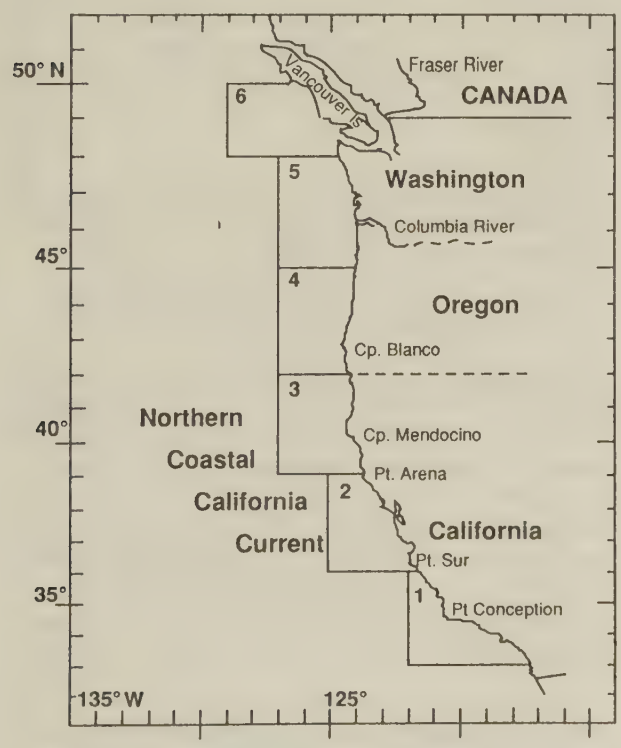


Figure 1. Northern coastal California Current divided into the six areas used in extracting and processing ocean temperature data.

sorted into six areas forming a continuous coastal strip 1900 km long from 33°N to 50°N that extends 200 to 300 km seaward, and includes the nearshore area of greatest variability and part of the offshore band of the California Current system where southerly flow is most consistent. The monthly mean anomalies were standardized at each depth and for each area to facilitate intercomparison of depths and equal weighting between areas. These standardized mean anomalies were then averaged to give a single seasonal value representative of the northern coastal California Current region. The monthly means for the entire area were then combined to give a single value for the fall and winter season (September 1 through February 28). Previous studies have shown that pronounced and prolonged seasonal California Current warm anomalies occur most frequently during this period. Finally, the interannual difference was obtained by subtracting the fall-winter seasonal anomaly of the previous season from the fall-winter anomaly value for the nominal fall-winter season. The interannual differences were obtained at each depth.

The monthly average sea level pressure at 45° x 165°W was used as source for the Aleutian low pressure system indicator. This was derived by averaging all 6-hourly analyzed pressure fields produced at FNOC for each month. First, the anomaly of the monthly mean was smoothed with a 6 month, fourth "centered", running mean. This made each month's value comparable to the ocean temperature series in terms of the time interval represented. However, only the December value of the current year in the atmospheric series would have a time window identical to the ocean temperature series. Next the interannual difference transform was applied to the atmospheric series by subtracting the anomaly value of the corresponding month in the previous year from the anomaly value for the nominal month of the current year. In this case the interannual difference transform is the same as the 12th difference transform.

The correlation field shown in Figure 2 was formed by correlating the inter-year difference series for the Aleutian low sea level pressure by month and the fall-winter California Current temperature change index at five depths in the upper 300 m. The interfacial nature of atmosphere - ocean interaction which is apparently responsible for the inverse correlation is shown by the rapid loss of inverse correlation with depth. A relatively high

inverse correlation, r=-0.78, is found at the surface in November. This inverse correlation decreases rapidly with depth and is less inversely correlated, r=-0.53, at 100 m. For 33 pairs of observations on unrelated variables the chance that r will have a value equal to -0.50 is p=0.01 and the probability that r will have a value of -0.40 is p=0.05.

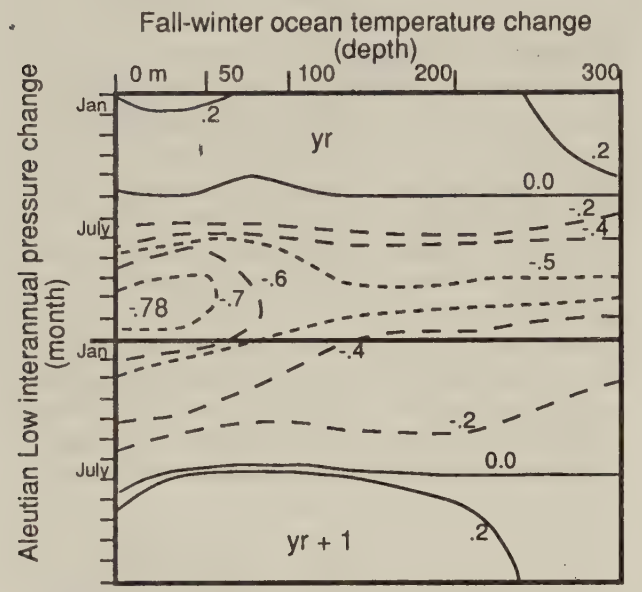


Figure 2. Correlation surface for fall-winter ocean temperature change index at 0, 50, 100, 200 and 300 m and monthly Aleutian low atmospheric pressure change index for January through December of the same year ("year", above middle line) and January through December of the next year ("year+1", below middle line). The middle line marks December 31 of the current year. Solid contours show positive correlation and dashed contours denote inverse correlation. Long (short) dashed contours are at intervals of 0.02 (0.01). For |r|>0.4, p=0.05.

In general, the relationship is seen to be seasonal, most obvious at the surface and in phase with depth. There is an apparent phase shift of one month, with the Aleutian low indicator leading correlated temperature changes in the California Current. However, it must be noted that the current analysis is not designed to show lead-lag relationships smaller than several months. It appears that the October, November, and December differences derived from sea level barometric pressure at 45°N x 165°W may be useful indicators of seasonal scale atmospheric influences on surface layer temperature changes in the northern coastal California Current during fall and winter. (J. Norton (408) 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

1989 Seychelles Purse Seine Fishery

Fourth quarter data for purse seiners fishing in the 1989 Seychelles fishery in the western Indian Ocean have been entered to SWFC data bases by John Childers, biological technician. The number of vessels operating in the fishery reached an all time high of 54 vessels in 1989 (Figure 1). The fishery was dominated by vessels from France (20) and Spain (23), with lesser participation from Russia (4), Japan (3), Mauritius (3) and Panama (1).

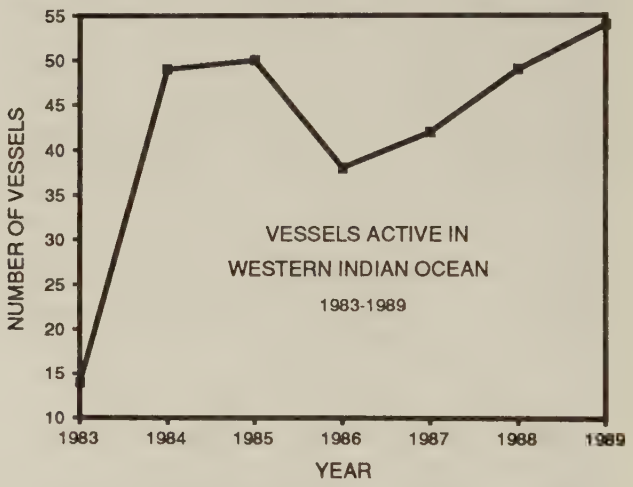


Figure 1. Vessels active in the Western Indian Ocean Seychelles purse seine fishery, 1983-1989.

Total catches in 1989 decreased slightly (3%) from catches in 1988, due mainly to a marked decrease in yellowfin tuna catches (35%, Figure 2). Skipjack catches accounted for approximately 67% of the catch, yellowfin 31%, and bigeye and albacore 2%. Decreased catches of yellowfin tuna were probably caused by oceanographic conditions that made fish unavailable to purse seines. Skipjack catches continued their steady climb reaching a record high since 1983 of 148,000 metric tons (t).

Overall catch rate decreased from 22 t per day fished in 1988 to 19 t per day fished in 1989 (Figure 3), owing primarily to yellowfin catch rate decreasing sharply (43%). Skipjack catch rates continued their steady climb increasing 8% over those recorded in 1988.

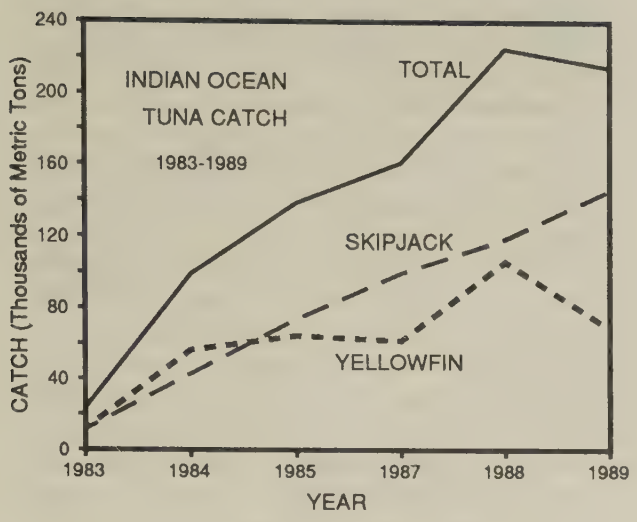


Figure 2. Tuna catches from the Western Indian Ocean Seychelles purse seine fishery, 1983-1989.

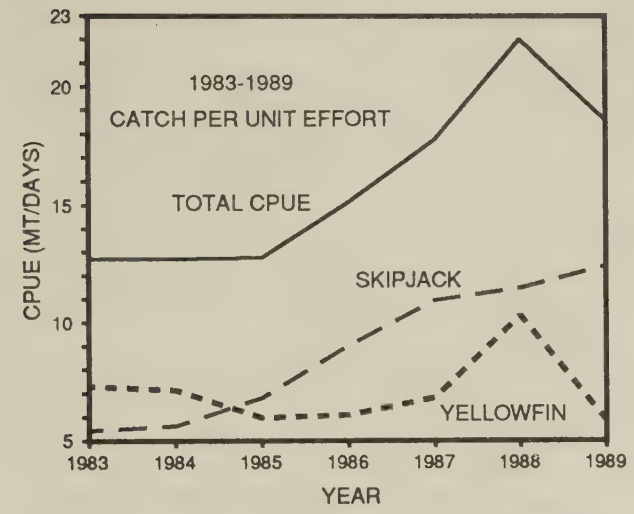


Figure 3. Catch rates (metric tons per day fished) in the Western Indian Ocean Seychelles purse seine fishery, 1983-1989.

(A. Coan, FTS 893-7079)

STOCK ASSESSMENT AND IMPACT ANALYSIS PROGRAM

U.S.-Japan Cooperative Albacore Research Conducted

The Southwest Fisheries Center, in cooperation with other research laboratories, in particular the National Research Institute of Far Seas Fisheries (NRIFSF) (formerly Far Seas Fisheries Research Laboratory), is conducting an assessment of the North Pacific albacore stock. Recent fishery data and analyses presented at the 11th North Pacific Albacore Workshop (May 1989) indicate that the albacore stock may be in much poorer condition than previously thought.

During the period February 5 through March 23, Norman Bartoo of the La Jolla Laboratory worked at the NRIFSF organizing cooperative albacore research with Yoh Watanabe and Hideki Nakano of the NRIFSF. Joint research projects so far agreed to are: 1) David Au, SWFC, will be working with Nakano to assess the condition of the stock with the latest data and traditional techniques; 2) Bartoo and David Holts, SWFC, will work with Nakano designing and executing experiments to estimate albacore loss rates from gillnet operations for inclusion in the stock assessment; 3) Pierre Kleiber, SWFC, will be standardizing different catch-per-unit of effort measurements; and 4) other SWFC researchers will be involved in other projects.

This research is conducted under an informal laboratory-to- laboratory agreement on albacore research begun in 1975. (N. Bartoo, FTS 893-7073)

Highseas Driftnet Impact Assessment

Planning for drift gillnet studies was initiated recently by Norman Bartoo and Dave Holts of the La Jolla Laboratory. A major focus of this new program, Stock Assessment and Fishery Impact Analysis Program, is on the impact of the driftnet fisheries on the North Pacific albacore stock and the U.S. troll fishery. This program is part of a larger study on driftnet effects in the North Pacific subtropical transition zone being managed by the Honolulu Laboratory.

Bartoo and Holts are designing studies on gillnet selectivity and albacore loss rate. Effects on survival of albacore that encounter high seas driftnets and escape will be measured by observers at sea. Six scientific observers will be deployed on selected U.S. jigboats. The observers will examine albacore for external gillnet marks, a sign that they escaped a net, and monitor the ratio of gillnet marked fish to total catch. Because marked fish are likely to face an increased risk of death due to injuries sustained during the encounter, observers will collect tissue samples from injured fish, record detailed information about the wounds, and make observations on number of driftnet vessels fishing near areas where catches are made.

Another planned experiment is to use a drift gillnet model in a shore-side wave tank. Dropout of entangled fish while the net is soaking, and with wave and surge action, will be observed. Data from these and other experiments will be used to understand the magnitude and causes of dropouts as well as the effects on driftnet-troll fishery interactions. These studies are being conducted in close cooperation with Japanese fishery scientists. (D. Holts, FTS 546-7186)

PELAGIC ECOSYSTEM MODEL DEVELOPMENT PROGRAM

Re-evaluation of Status of North Pacific Albacore Stocks

In preparing a working paper for last year's North Pacific Albacore Workshop, Pierre Kleiber at the La Jolla Laboratory calculated the annual catch-per-unit-effort (CPUE) in the U.S. North Pacific jig fleet using a different formula than had been routinely used in past years. The routine formula was to pool the catch over all spatio-temporal strata in a given year and divide by a similarly pooled effort. In the new formula, Kleiber calculated the CPUE in individual strata and averaged over all strata in a given year. The two formulas give different results (Figure 4), particularly in the past decade where the rising trend for the pooled CPUE is in contrast to the downward trend for the averaged CPUE.

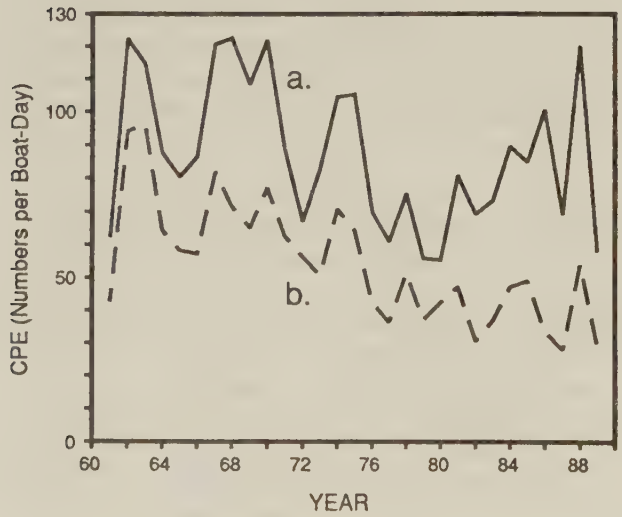


Figure 4. Catch-per-unit-effort. (a) Pooled catch divided by pooled effort; (b) average of individual catch-per-efforts.

Kleiber has completed a manuscript in which he shows that the divergence of the pooled and averaged CPUE time series is consistent with a situation where the resource is patchily distributed and a growing ability of the fishery to locate the high density patches. In searching for corroborative evidence that the fishery has been increasingly favoring high abundance strata, i.e., patches, he ranked the spatio-temporal strata in each year by their catch-per-effort values. Taking the top 20th percentile of strata so ranked, he found that the percent of the total effort in a year expended in that percentile has been tending upwards, particularly over the last decade (Figure 5). This change could be due to a variety of factors including the increasing use by this fishery of SWFC's weekly advisories to locate dense albacore patches.

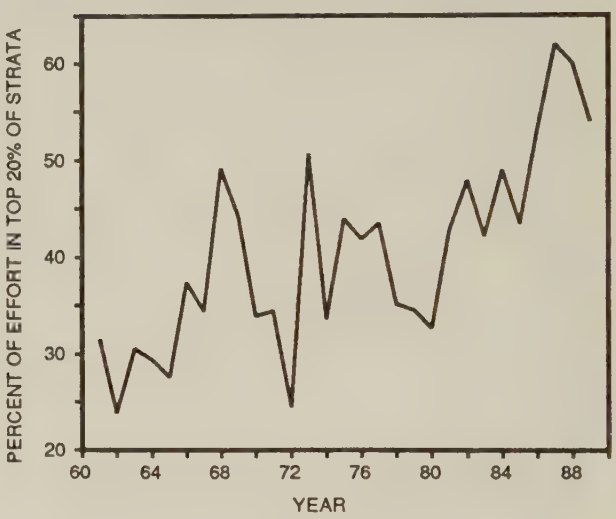


Figure 5. Percent of effort in each year in top 20th percentile of strata where strata are ranked by catch per effort.

Whatever the cause, the annual, routine CPUE values (pooled catch divided by pooled effort) has an increasing, positive bias as an estimator of population abundance. Also the new formula (average of individual CPUE) has a lesser, but also increasing, positive bias. The implication of these results is that the actual trend in the population should have been a more severe decline than is indicated by the new formula (Figure 4). Therefore the condition of the North Pacific albacore stock must be much less favorable than the heretofore optimistic appraisals of this resource. (P. Kleiber, FTS 893-7076; C. Perrin, FTS 893-7078)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH COMMUNITIES INVESTIGATION

Mortality Estimates for Blue Rockfish Refined

Because natural mortality during early life history is likely to be the major source of variability in recruitment of rockfishes (*Sebastes* spp.), Fishery Biologists Peter Adams and Dan Howard have estimated the instantaneous natural mortality coefficient for the blue rockfish, *Sebastes mystinus*. The estimates refer to mortality during the period from August, when the numbers of recruits have stabilized, until the following April (Figure 1). Using what is in essence a catch-curve analysis, natural mortality is considered to be represented by the slope of a plot of the natural logarithm of abundance against elapsed time. The data, which provide mortality estimates for the 1985 to 1988 year classes (Table 1, Figure 2) are from SCUBA line transects at three nearshore sites along the coast of northern California. An earlier report (Bimonthly Report of Activities, March-April 1989) described the transect sites and sampling methods and also presented preliminary mortality estimates. Here the estimates are refined.

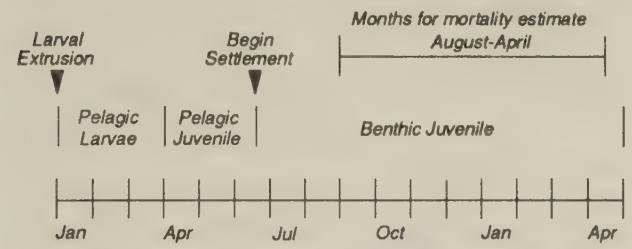


Figure 1. Time line for early life stages of blue rockfish, *Sebastes mystinus*.

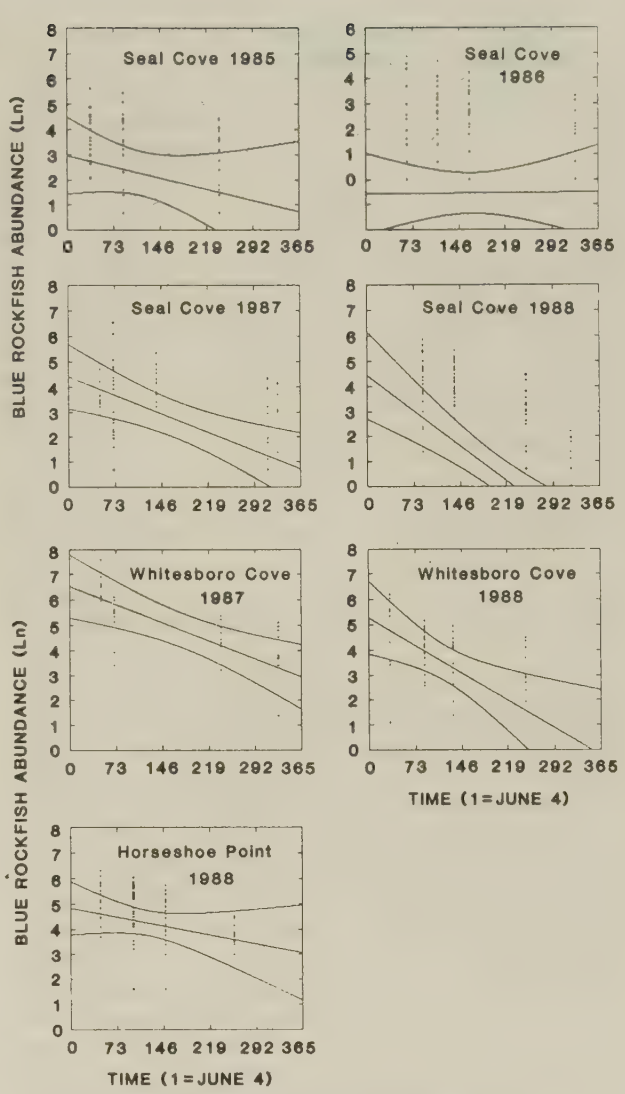


Figure 2. Natural mortality estimates for juvenile blue rockfish from different locations and years.

Table 1. Instantaneous natural mortalities for first year juvenile blue rockfish (*Sebastes mystinus*) in northern California habitats.

Location	Year class	Natural mortality (d^{-1})	S.E.	F	Prob
Seal Cove					
	1985	0.004	0.002	3.08	0.084
	1986	0.002	0.001	3.31	0.074
	1987	0.005	0.001	11.97	0.001
	1988	0.011	0.001	56.45	>0.001
Whitesboro Cove					
	1987	0.010	0.002	18.23	>0.001
	1988	0.009	0.002	19.05	>0.001
Horseshoe Point					

Inter-annual differences in mortality estimates were insignificant during three of the four years. The

Table 2. Published values for instantaneous mortalities in juvenile fishes.

Species	Instantaneous mortality (d^{-1})
Blue rockfish	0.002-0.011
Shad	0.0192
Winter flounder	0.0121
Atlantic herring	0.0171
Plaice	0.015
Largemouth bass	0.0294
Striped bass	0.0151
Spot	0.0419
Atlantic croaker	0.0230
Anchovy	0.0150
Pink salmon	0.0300

exception was the 1988 year class at Seal Cove (Table 1). This was the strongest of the four year-classes with consistently high, though declining counts through most of the monitoring period. The high mortality estimate for that year-class resulted from an abrupt decline in numbers during April. Although it is possible that these counts reflect a sudden increase in mortality at the end of the monitoring period, it is more likely they detected the migration of juveniles out of the area at that time. There has been evidence of such a migration in late March or April during the 13 years that the Groundfish Communities Investigation has been monitoring the first-year juveniles. If this possibility is borne out in further study, it will be necessary to terminate the assessments a month or two earlier.

Sufficient data are not yet available to examine with confidence differences in mortality between locations. Only the 1988 year class was monitored at all three locations, and for reasons given above the Seal Cove estimate for that year is suspect. In 1987 the Seal Cove estimate was lower than at the other two sites.

Considering that circumstances were so varied, the estimates have been remarkably consistent, and we regard them with reasonable confidence. They tend to be lower than published mortality estimates for other species (Table 2), and if the temporal and spatial consistency evident so far continues to hold under more intensive investigation, it would appear that natural mortality at this stage of their life history has little impact on ultimate relative success of the year class. (P. Adams and D. Howard, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATION

Surveys of Pelagic Larval and Juvenile Rockfish Completed

Scientists of the Groundfish Analysis Investigation have recently completed two cruises intended to survey the distribution and abundance of pelagic larval and juvenile rockfish (*Sebastes* spp.) inhabiting the coastal waters off central California.

The first cruise (February 26-28) was designed to survey early larvae of shortbelly rockfish (*S. jordani*). The area surveyed was in the vicinity of Pioneer and Ascension Canyons, located 10-30 nm offshore between Half Moon Bay and Monterey Bay. Large schools of adult shortbelly rockfish are known to inhabit this area. Fishery Biologists Steve Ralston, David Woodbury and Tom Laidig worked aboard the chartered Bodega Marine Laboratory R/V *Susan K.* All scheduled work was completed; however, the vessel was not capable of strictly following standard CalCOFI bongo tow procedures. A total of 35 stations along six transects was sampled with a bongo frame equipped with two 505 µm mesh nets and 333 µm codends. At each station a CTD (Seabird SBE 19) was deployed to collect temperature and salinity profiles. Although other species of larval rockfish were present in the samples, shortbelly rockfish dominated the catch. Results (Figure 3) indicate that two areas of spawn-

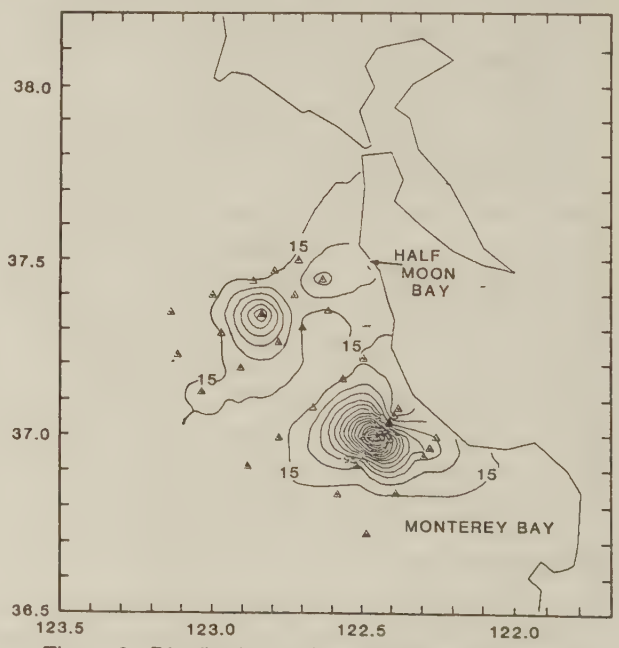


Figure 3. Distribution contours represent the number of larval shortbelly rockfish per tow and are at 40 larvae per tow intervals. Triangles represent stations.

ing occurred prior to the survey. The northern concentration was located south of Pioneer Canyon, while the southern concentration was adjacent to Ascension Canyon. Maximum counts from northern and southern areas are 270 and 827 fish per tow, respectively. These two areas correspond to the historical centers of adult shortbelly rockfish abundance.

The second cruise (March 26-April 8) was part of the annual survey program begun in 1983 to determine the distribution and abundance of juvenile rockfish inhabiting the nearshore waters between Monterey Bay and Point Reyes. The cruise was conducted aboard the NOAA Ship *David Starr Jordan*. The work involved daytime CTD casts to obtain temperature and salinity data and nighttime midwater trawls to capture juvenile rockfish. Cruise Leader David Woodbury reports that the juvenile rockfish sampled (535 specimens) were less abundant and smaller than those collected on cruises conducted during a similar time in 1987-88. Many large catches of euphausiids were made, indicating that, at least for euphausiids, the waters are productive this year. (D. Woodbury, FTS 556-0565)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Fecundity Research

Field collections for the 1989-90 reproductive period of yellowtail rockfish were completed in March. A total of 347 adult fish consisting of 280 females and 67 males was collected and examined for physiological condition and reproductive state. To provide geographic comparison with data from fish previously gathered from Cordell Bank, CA during the previous 5 years, we obtained specimens from commercial landings at Vancouver, BC (113 fish), and Westport, WA (110 fish). Preliminary results of the examinations showed that reproduction of Washington and Canadian yellowtail rockfish preceded that of California fish throughout the entire season. Further, California fish were in generally poor condition with depleted energy stores during this time. This was most notable in the low mesenteric fat reserves, low liver weights, and extensive fungal infections in the spleens, kidneys and livers. Fecundity measurements are presently underway and they should allow determination of whether this poor condition affected reproductive effort of California yellowtail rockfish.

Fecundity measurements of Washington State yellowtail rockfish during the 1988-89 reproductive

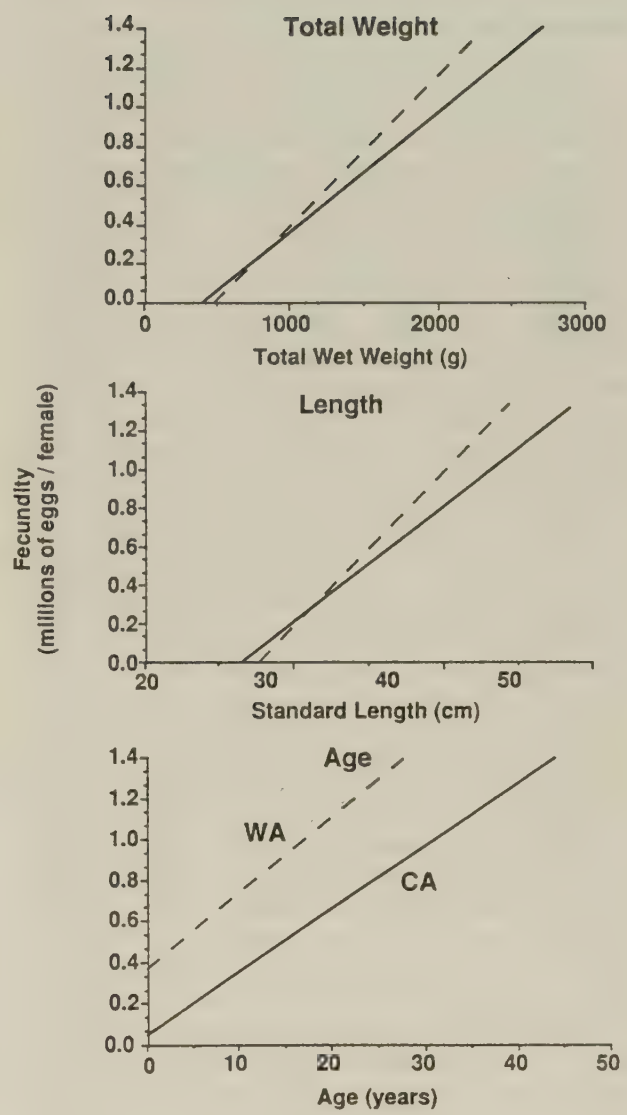


Figure 4. Fecundity at total body wet weight, length, and age of yellowtail rockfish from Cordell Bank, CA (solid line), and Westport, WA (dashed line).

season were recently completed and they showed that fecundity at length was higher in Washington fish (38 cm) than in Cordell Bank, CA fish. Also fecundity at weight was similar while fecundity at age was higher at all ages in Washington fish (Figure 4). Much of the higher apparent productivity in Washington fish may be due to their overall good condition. Mesenteric fat during egg development and gestation periods was consistently high and stomach contents indicated abundant prey sources (primarily fish, versus occasional euphausiids for Cordell Bank fish). (M. Eldridge and B. Jarvis, FTS 556-0565)

Chromatophoromas in Adult Yellowtail Rockfish

Dr. Jeannette Whipple has received several reports from Dr. Mark Okihiro, University of California at Davis, on pigmented tumors of yellowtail rockfish collected from Cordell Bank. The pigmented areas have been identified as either chromatophore hyperplasia or neoplasia (chromatophoromas or pigment cell tumors). Types of hyperplastic lesions observed included melanophore (black), xanthophore (yellow), and erythrophore (red or orange). Pigment cell tumors seen were melanophoromas, amelanotic melanophoromas, xanthophoromas, and mixed chromatophoromas. Hyperplastic lesions were sessile while tumors tended to be raised. Melanophore hyperplasia was the most common lesion and was usually found in the head region, over the jaws, and dorsal surface of the fish (areas normally having more chromatophores). Melanophore hyperplasia, which is non-invasive, was thought to be an early preneoplastic stage in the eventual development of pigment cell tumors.

There was a 10% prevalence of melanophore hyperplasia (70 fish/668 sampled) at Cordell Bank. Melanophoromas were identified in only 10 of 668 fish (1.5% of fish sampled), but it is possible that many fish with invasive malignant tumors have died. We have not observed chromatophore hyperplasia or neoplasia in fish sampled from populations further north. Fish with melanophore hyperplasia appeared to be in poorer condition than unaffected fish. Examination of outliers indicated that, for most condition variables, fish with melanophore hyperplasia fell in the extreme upper 10% for parasite infections and in the lower 10% for condition variables. (J. Whipple, FTS 556-0569)

Loosanoff Collection Being Sent East

Dr. Tony Calabrese from the Milford Laboratory and Dr. Jeannette Whipple and Maureen Woods from the Tiburon Laboratory are completing arrangements to ship microscopic slide material, photographs and other research notes and data belonging to the late Dr. Victor Loosanoff to Oxford and Milford Laboratories. Tamara Loosanoff has donated this material to the National Marine Fisheries Service in accordance with Dr. Loosanoff's wishes. This includes an excellent collection of material on mollusks, particularly oysters and clams, from all over the world. We hope that the value of this collection will be appreciated by others in the field. (J. Whipple and M. Woods, FTS 556-0565)

INFORMATION TECHNOLOGY SERVICES.

ITS Programming Assistance

Parallel testing of the programs for the Monk Seal Census Data program conversion task was begun by Thea Johanos-Kam of the Honolulu Laboratory in conjunction with Susan Jacobson of ITS. Jacobson has converted this long-running series of programs to operate on a PC, currently adding finishing touches to the final program. Together, they are fine-tuning the instructions and operations of the new programs, as well as the new format adopted with the conversion. Jacobson will up-date the documentation when this step is concluded.

Jacobson also worked with Cindy Meyer of the Coastal Fisheries Resources Division to debug C programs that Meyer's group uses for cruise planning. The original intent was to convert the programs from Turbo C to Microsoft C because it appeared that Turbo C was not handling floating point numbers correctly. However, the two worked together on the conversion, improved the programs' efficiency, and determined that they operated efficiently using the new release of Turbo C with renovated floating point operations. (S. Jacobson, FTS 893-7060)

FTS2000 Cutover Completed

On Friday, April 20, 1990, with the help of AT&T, Pacific Bell, U.S. West Telecommunications, Comstock Communications, and Centel, the La Jolla Laboratory's phone service was converted from FTS to FTS2000. FTS2000 is provided by AT&T and Sprint on two different networks. We are serviced by AT&T on the "A" network. The FTS2000 will provide us with better quality, more reliable voice communications in a more cost effective manner. (R. Bistodeau, FTS 893-7055)

PUBLICATIONS

Published

Balazas, G.H. 1989. New initiatives to study sea turtles in the eastern Pacific. Mar. Turtle Newsl. 47:19-21.

Boehlert, G.W., W. Watson and L.C. Sun. 1989. Distribution of larval fishes around an isolated oceanic island and the role of larval retention in population maintenance. (Abstract) Rapp. P.-v. Reun. Cons. Int. Explor. Mer 191:448.

Gerrodette, Tim and Douglas P. DeMaster. 1990. Quantitative determination of optimum sustainable population level. Mar. Mammal Sci. 6(1):1-16.

Quantitative methods are reviewed and compared for determining whether a marine mammal population is at an optimum sustainable population (OSP) level, a management goal specified by the U.S. Marine Mammal Protection Act. Methods of OSP determination fall into two general types: those that require an estimate of a population's maximum net productivity level (e.g., the back- circulation method) and those that do not (e.g., dynamic response analysis). The two types differ in the data they require and in whether they determine OSP with respect to present or historical carrying capacity. Back-calculation and dynamic response analyses are compared using data on the California gray whale (*Eschrichtius robustus*). Marine mammal monitoring programs should be designed to detect trends in both the abundance of a population and its condition relative to carrying capacity, because both quantities are involved in the definition of OSP. The value of using both abundance and condition indices in an assessment is illustrated with data on the northern fur seal (*Callorhinus ursinus*).

Herrick, S.F., Jr. and D. Squires. 1989. Integration of United States, Thailand and Philippine canned tuna markets. Asian Fish. Sci. 3:85-99.

In this study we investigate price integration in the United States, Thailand and Philippine canned tuna markets by employing a dynamic model of spatial price differentials to determine how rapidly and completely price information is transmitted from one market to another over time. When the United States is assumed to be the central canned tuna market, we find that the Thai canned tuna market operates independently of price conditions in the United States. On the other hand, the Philippine market is well integrated with the United States market in the sense that a change in the United States price is quickly and effectively communicated to the Philippine market. These results are shown to have significant implications with regard to measures the United States might take to control the flow of canned tuna imports from Southeast Asia.

Hightower, Joseph E. 1990. Biomass-based models and harvesting policies for Washington-Oregon-California rockfish stocks with correlated recruitment patterns. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-137, 27 p.

Methot, Richard D. 1989. Synthetic estimates of historical abundance and mortality for northern anchovy. Am. Fish. Soc. Symp. 6:66-82.

The stock synthesis model combines the analyses of catch, abundance, and age-composition data. The model seeks the most likely time series of abundance and mortality, and distributes the residual error among all types of data according to each type's consistency with the synthetic estimates. The data base for northern anchovy *Engraulis mordax* includes two independent fisheries, an auxiliary source of age-composition data, a 6-year time series of accurate spawning biomass measurements by the egg- production method (EPM), and two longer time series of biomass indices. Specific biological relationships in the northern anchovy model are an influence of chub mackerel *Scomber japonicus* on natural mortality, and an influence of ocean temperature on patterns in age-specific availability and the fraction of 1-year- old fish that are mature. The synthetic estimates of spawning biomass since 1980 typically are within 15% of the measurements made by the EPM. This high precision demonstrates the consistency between changes in biomass measured by the EPM and changes expected from recruitment information in the age-composition data. Consistency between the other biomass indexes and age-composition data were lower. Nevertheless, the other biomass indexes are valuable for defining trends in the estimated 33-year time series.

Morales-Nin, B. and S. Ralston. 1990. Age and growth of *Lutjanus kasmira* (Forskål) in Hawaiian waters. J. Fish Biol. 36:191-203.

The growth of Hawaiian taape, *Lutjanus kasmira*, was studied by examining otoliths and by analysing length-frequency distribution. Annual hyaline and opaque markings were visible in whole mounts of sagittae, which were verified by enumeration of daily increments with a scanning electron microscope (SEM) and through marginal increment analysis. The von Bertalanffy growth curve was fitted to the data, resulting in:

$$T.L.=34.0\{1-\exp[-0.29(t+1.37)]\}$$

where T.L. is total length (cm) and t is age (years). SEM observations revealed that the slow-growth hyaline zones were composed of daily increments too small (0.4-0.8 mm) to be resolved optically. Thus, age estimates derived by numerically integrating otolith growth rate data obtained with a light microscope showed a negative bias, resulting in overestimation of growth rates. Parameter estimates obtained from three different types of length-frequency analysis were also unstable. This was due, at least in part, to differences in the size composition of fish sampled with different fishing gears and from different depths.

The growth rate registered in Hawaii falls within the reported growth coefficients of lutjanids, whereas it is one of the highest in the Pacific and clearly higher than that of a deep-water lutjanid species (*Pristipomoides filamentosus*) in Hawaii. Probably, this high growth rate may have been enhanced by the relative lack of competitors in the depauperate Hawaiian marine fish community.

Perrin, William F. 1990. *Steno attenuatus* Gray, 1846 (currently *Stenella attenuata*; Mammalia, Cetacea):

proposed conservation of the specific name. Bull. Zool. Nomencl. 47(1):32-37.

The purpose of this application is to conserve the specific name of the pantropical spotted dolphin, *Stenella attenuata* (Gray, 1846), the type species of *Stenella* Gray, 1866. The specific name is threatened by three subjective synonyms, only one of which has been mentioned (as a probable synonym) during this century.

Polovina, J.J. 1989. Artificial reefs: Nothing more than benthic fish aggregators. Calif. Coop. Oceanic Fish. Invest. Rep. 30:37-39.

Ralston, S. 1989. Effect of seasonal recruitment on bias of the Beverton-Holt length-based mortality estimator. Am. Fish. Soc. Symp. 6:190-197.

The Beverton and Holt mortality estimator is a length-based formulation often applied to tropical fish stocks. Although constant uniform recruitment of fish to the exploitable phase is an important condition of its derivation, the robustness of the estimator when this assumption is violated has never been studied. This is important because evidence from the literature shows that in the tropics (i.e., Hawaii) both recruitment and spawning are distinctly seasonal events. Thus, to study properties of the estimator when recruitment is variable, a simple model with seasonal reproduction was developed and analyzed. I show that if age is measured discretely in units equal to the period of the recruitment function, typically 1 year, the age distribution is stationary. The model is extended to length distributions and used as a basis for Monte Carlo simulation of the estimator. Results show that, seasonally, the time of sampling has a major effect on the relative bias of mortality estimates. Bias is negative during periods of increasing recruitment and vice versa, whereas no bias exists at times of maximal and minimal recruitment. Likewise, as the underlying mortality rate increases, bias becomes more severe. When multiple length-frequency samples are drawn and the data and estimates are aggregated, relatively little bias is evident. These results suggest that, when the estimator is used in situations in which recruitment is periodic, it may be better to obtain many small samples than a single large sample, unless some prior information exists concerning the form of the recruitment function.

Approved by Science and Research Director, SWR

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